The New Zealand
Journal of Agriculture.

VOL. 55. WELLINGTON, 20TH OCTOBER, 1937. NO. 4.

RECLAIMED TIDAL LAND AT PIPIROA.

THE VALUE OF STRAWBERRY-CLOVER.

By J. E. BELL, Instructor in Agriculture, Auckland.

THE littoral clay soils of the Hauraki Plains dry out quickly in dry weather. At Pipiroa there are about 800 acres of reclaimed land which have been stopbanked from sea and river and drained. This area is roughly triangular in shape and is bounded on the north by the sea-coast and on the east by the Piako River. The soil is a stiff clay. The drains, which were dug, proved reasonably effective, and after the land became sufficiently free of salt the area was sown in pasture. This soon grew luxuriantly, and the resultant sole of rye-grass and white clover supported highly productive dairy herds, and was famed on the Hauraki Plains for its health-giving and fattening properties. After a few years of dairying, and probably as the result of winter trampling and puddling of the soil entailed by dairying, the drainage system became less efficient. About fifteen years ago deterioration of the pastures was first noticed, and culminated in the dry summer of 1928–29 in the disappearance of almost all the pasture-plants on the reclaimed land and also on other patches, on clay soils in the vicinity of Pipiroa, and also on isolated areas as far inland as Ngatea. The depleted areas comprised, in all, about 1,000 acres of land. The worst damage was apparent in the reclaimed triangular area at Pipiroa, which was almost bare of vegetation. At the margins of this area and on the other areas almost all the grass was dead, but the dead stalks of grass were still to be seen. Throughout the depleted areas there were still alive a few patches of *Poa pratensis* and prairie-grass, and odd plants of tall fescue and meadow-foxtail. These grasses did not appear to suffer much.

One piece of ground at Pipiroa was conspicuous for its distinctive green colour—a patch of strawberry-clover (*Trifolium fragiferum*) a few square yards in extent in one of the fields on Mr. J. Mangan's property. This patch, no doubt the result of the establishment of one seedling, was to play, and continues to play, an important part in the rehabilitation of the area at Pipiroa, but its virtues were not fully realized till later. What had occurred was the destruction of the rye-grass and white clover, which held so dominant a position in the pastures that their disappearance left a desolate desert.

FIG. 1.—THE DEPLETED LAND AT PIPIROA: BARE GROUND, BUTTERCUP, DOCKS.

FIG. 2.—A PASTURE OF REVERSED CLOVER AND POA ANNUA, WITH ODD PLANTS OF BUTTERCUP, LOTUS, AND RYE-GRASS.

Settlers in Sorry Plight.

The settlers were in a sorry plight, and, as a result of their complaints, the country was examined by officers of the Department of Agriculture. The bare soil had cracked very badly, and these cracks formed ideal homes for crickets, which were present in their millions. They would hop and flutter in dozens at each step of the visitor as he walked across the fields. They nibbled the remaining pasture and anything lying about that was eatable, and were even known to devour clothes and to fight and eat each other. A caterpillar of the *Porina subterranea* species was also present on the marginal land, where the grass was dying and where the ground was still covered by dead stalks of rye-grass.

Various opinions were expressed by farmers and others as to the cause of the depletion. Many farmers blamed the crickets, and said that they were the sole cause of the trouble, while others were as emphatically of the opinion that the crickets were not entirely to blame. The presence of the *Porina* led a few to believe that this caterpillar, after destroying the rye-grass, had disappeared from the bare areas and was working its way along the marginal land and in freshly attacked patches, making further inroads into the untouched grassland. Others believed that the trouble was caused by the surface layers of the soil becoming poisoned by salt deposited there, as the soil moisture, with the salt in solution, rose by capillarity and evaporated at the ground surface. This trouble would be prominent in dry summers, yet there was no visible sign of alkali on the ground surface. Another theory was that, as the area was not well drained, the puddling of the area by dairy cows each winter had resulted in an alteration of the physical nature of the clay, so that it cracked and dried out so badly in the summer that the rye-grass died.

Investigations were started in 1929–30, the season following the year of marked deterioration. An area was sown down in various mixtures of grasses with a basal clover mixture of white clover, strawberry-clover and *Lotus major*. The area was manured with ammoniated super. Later it was realized that this manurial dressing was unsuitable for sowing down, due to its inimical effect on clover establishment. Certainly the pasture had to struggle to live, and in the early periods the death of the grasses was feared. Fortunately the 1929–30 summer was a wet one, the following five seasons were not dry ones, and gradually the pastures on the trial area improved and finally became fairly well established. The following grasses were tried: perennial rye, Italian rye, meadow-fescue, *Paspalum dilitatum*, cocksfoot, crested dogstail, meadow-foxtail, *Poa trivialis*, timothy, and *Phalaris bulbosa*. Different chemical treatments were tried, including super, slag, carbonate of lime, gypsum, 30 per cent. potash salts, sulphate of ammonia, sulphur, nitrochalk, and manganese sulphate.

Seasonal Changes.

In the meantime parts of the depleted area showed amazing changes at every season of the year. The bare ground became colonized chiefly by buttercup, dock, pennyroyal, and sowthistle (all high-fertility-demanding weeds), and by *Poa annua*, goose-grass, reversed clover (*Trifolium resupinatum*), and *Lotus major* and *Lotus hispidus*. Favoured well-stocked areas such as night paddocks contained much reversed

FIG. 3.—TWO PLANTS OF REVERSED CLOVER, SHOWING HABIT OF GROWTH AND THE TYPICAL SEED-HEAD.

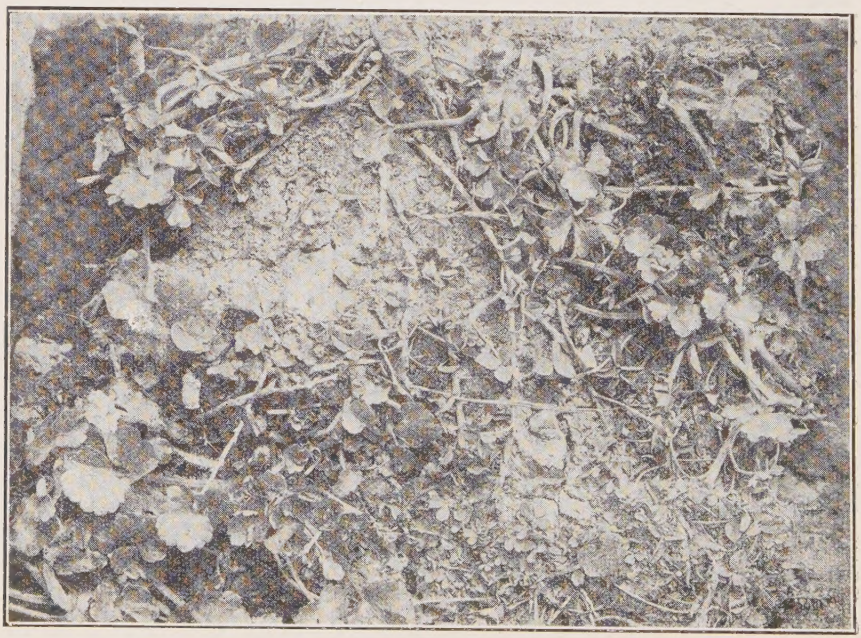


FIG. 4.—STRAWBERRY-CLOVER STOLONS INVADING DEPLETED LAND, WHICH WAS MAINLY BARE GROUND, WITH ODD PLANTS OF BUTTERCUP, SCOTCH THISTLE, AND LOTUS.

clover and *Poa annua*, and a little perennial rye, while less favoured areas were only sparsely colonized by *Lotus major* and weeds. If two consecutive wet summers were experienced, white clover and volunteer rye-grass would reappear in some of the fields, and these for a time would be quite highly productive. Under clumps of trees, particularly around homesteads, where excessive grazing was not allowed, and where the tree-roots prevented undue trampling by stock, patches of prairie-grass, thriving very well indeed, could be seen. One or two attempts were made to establish prairie-grass in the open fields, but it did not prove to be of high production under such conditions. On one of the night paddocks meadow-foxtail was present to a fair extent. On some hayfields there would be much goose-grass, a pasture-plant of low production. There was also one patch of *Agropyron repens* permanently established. The dry-soil condition in the summer was suitable to this grass, which, however, was in a rather sodbound condition, with no clover present in its midst. In consequence its production was only fair, and it was neglected by stock. All these different types of pasture, although welcome because they provided some feed, were viewed as unsatisfactory by the settlers, who had been accustomed to, and expected to see, permanent high-class swards of rye-grass and white clover.

Most of the farmers adopted the policy of *laissez-faire*, which perhaps was the most sensible one to adopt. Some attempted to grow crops of maize, barley, soft turnips, and other supplementary crops for their cows. These were grown with difficulty, as the soil was wet and heavy and difficult to cultivate, and once cultivated was very soft in the winter. Of the crops, maize gave the best results, and barley was quite successfully grown. Small patches of lucerne were grown with slight success by one or two farmers, but the ground was too wet for the production of good crops.

Heavy Crops of Hay.

In autumns following dry summers the annuals and some perennials would establish themselves from seed and would form root systems throughout the winter months, but during this period of establishment the production of leafage was poor. *Poa annua* gave most of the fodder, and, though of slow growth, produced highly palatable and nutritious feed, and proved a very useful volunteer. The reversed clover produced very little feed in the winter, but in the spring fields colonized by it grew an enormous amount of highly nutritious fodder. Extremely heavy crops of hay, of up to 3 tons per acre, were secured from this clover, the growth of which in favourable seasons suppressed almost all other plants in the sward. Reversed clover has a leaf very similar to white clover in appearance, being hairless and of as fine a texture. It forms small rosettes in the winter and early spring about 6 in. in diameter. In the spring it sends up tall upright stems about 3 ft. long (some specimens have been reported to be 5 ft. long). These stems are slender (much finer than lucerne), and hay crops usually lodge and are difficult to cut. The flower-head is small and contains about twenty-five florets like white clover florets, only they are of a light purple colour. Each floret develops a single seed, which becomes

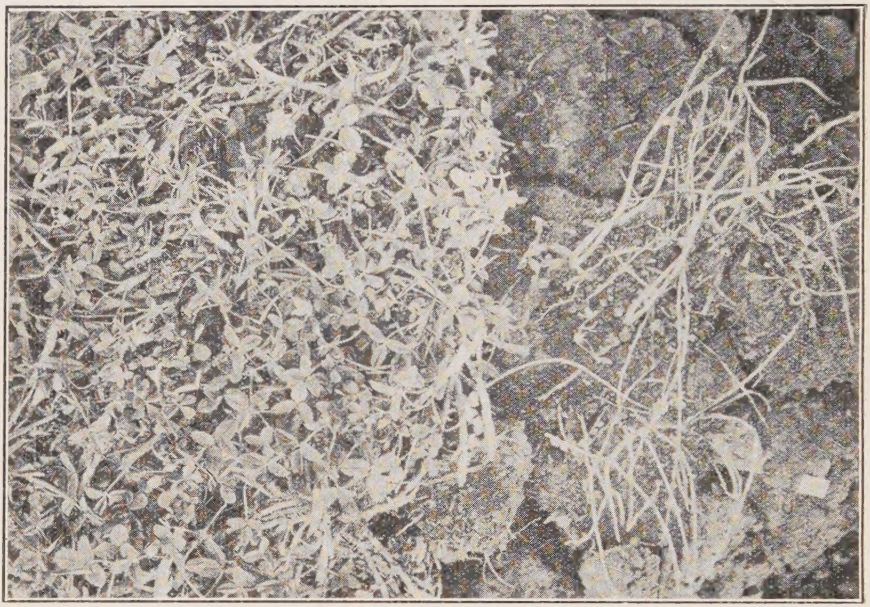


FIG. 5.—STRAWBERRY-CLOVER INVADING IN MASS FORMATION PRACTICALLY BARE GROUND.

Notice the dead stalks of pennyroyal on the uninvaded territory.

FIG. 6.—STRAWBERRY-CLOVER WELL ESTABLISHED ON DEPLETED LAND.

enveloped in a veined diaphanous capsule. When the capsule has enveloped the seed the seed-head has a strawberry-like appearance, and is about ¾ in. in diameter, much larger than the flower-head.

By Christmas both the *Poa annua* and the reversed clover would be dead, and in the dry Januaries and Februaries usually experienced practically no vegetation would be produced. In wet summers there would be some white clover and *Lotus major* growth. Thus as the seasons varied and the management changed on the different fields, so the sward would alter with lightning rapidity (or so it would appear to the periodic visitor). One wet summer encouragement would be given to the presence of white clover and some rye-grass on favoured areas. Next spring there would be the usual thick tangled mass of reversed clover, then a dry summer and a hopeless looking bareness. Always a fight was going on between annuals and perennials. Wet summers favoured the survival of perennials, and thicker swards of these in the autumn meant less and weaker annuals and a poorer showing of them in the spring. Dry summers meant death to perennials and a bare soil for the seedling of many annuals, which were then not hampered by perennials in their establishment in the winter, and grew vigorously. The weakness of a pasture populated chiefly by annuals was very evident, the production from January to September being very low. In spite of the very high production during the remainder of the year by reversed clover, the butterfat-production was only a fraction of that when the area was carrying a sole of perennial rye-grass and white clover. A pasture of this kind would not perhaps be quite as high-yielding in the spring, but its production during the rest of the year would eclipse that of the annuals now growing in its place. Most of the area was not evenly thickly populated by annuals, and the production was low in the extreme.

Manurial Experiments.

The manurial experiments were of little value, for most of the treatments made no impression, and the others had little noticeable effect. The most promising of the treatments were super, slag, and potash. The only grass that proved of value in the trials was perennial rye-grass, and this established itself only where there was a good sole of volunteer reversed clover or strawberry-clover. The rye-grass was most vigorous and plentiful where strawberry-clover was well established. All other grasses except *Phalaris bulbosa* and paspalum made a showing. *Phalaris bulbosa* has become aggressive, and not being liked by stock is proving a nuisance. The paspalum threw very little feed.

Strawberry-clover established.

In the 1934–35 season there was another dry summer almost as arid as the summer of 1928–29, and, with the exception of a few patches, the pastures once more disappeared on the deteriorated areas. These patches when examined proved to be areas where strawberry-clover had established itself. Some of the settlers had suspected by now that the cure of the trouble was strawberry-clover establishment. One or two had commenced to sow and plant it in their fields, and the one patch which had demonstrated its value in 1928 had now spread, chiefly by natural means, over several fields.

FIG. 7.—THE FINAL STAGES—A STRONG PASTURE OF RYE-GRASS AND STRAWBERRY-CLOVER, WITH WEEDS AND ANNUAL AND INFERIOR PASTURE-PLANTS ELIMINATED

FIG. 8.—A SIDE VIEW OF TURF NO. 7 (RYE-GRASS – STRAWBERRY-CLOVER PASTURE).

Note the strong root-growth of strawberry-clover showing at the side of the turf.

Strawberry-clover is a perennial plant, is like white clover in its habit of growth, spreading over the ground by means of stolons. Like white clover also it is a twitch, and the stolons strike roots at the nodes. But, unlike white clover, it is very deep-rooting and its roots will penetrate over 20 in. into the soil. This deep-rooting habit explains its successful growth on dry or salty soils and its high summer production. The leaflets of strawberry-clover are hairless and similar in appearance to those of white clover. A distinguishing feature, however, is that they are generally long and narrow compared with white clover leaflets. The flower is very similar to the white clover flower, but the petals usually have a pinkish tinge. Later it forms the strawberry-like seed-head from which it receives its name. The seed-head is similar to the reversed clover seed-head just described.

Strawberry-clover establishes itself best in damp situations, whether from seed or transplanting. When established it grows best where the drainage is good. It will exist in drier or more salty and in wetter conditions than white clover. It demands high fertility—probably higher fertility than even white clover for vigorous growth. In the winter and in wet summers it grows less vigorously than white clover. In dry summers, however, it excels.

Strawberry-clover can be seen at Pipiroa invading territory but sparsely populated by weeds and annuals. It is a better colonizer than reversed clover, and is occupying fields poorly favoured by stocking in which reversed clover has not established, although given every opportunity to do so. The strawberry-clover at Pipiroa suffers in that it is a shy seeder. It is essentially a leaf-producer. If it was as prolific a seeder as reversed clover, there would be no depleted land now at Pipiroa. After strawberry-clover has established itself, perennial rye-grass commences to grow in its midst, and the pasture becomes a rye-grass - strawberry-clover one. Such a pasture is capable of high butterfat-production per acre, comparable to rye-grass and white clover. The rye-grass produces most of the feed in the autumn, winter, and spring, and the strawberry-clover in the summer. Strawberry-clover being a permanent clover of high production, and providing a dense cover of the ground, is similar in habit to white clover. At Pipiroa it is successfully taking the latter's place.

Cause of Deteriorated Pastures.

By now it was fully realized that the deterioration of the pastures was caused by the death of white clover. White clover holds a key position in our high-class pastures, and if it fails the pasture-grasses suffer. A sequence of events may follow the failure of white clover such as befell the pastures at Pipiroa, leading to almost complete destruction of the sward. One is tempted to portray the probable sequence at Pipiroa because it is interesting and may serve as a basis to work on where other instances of depletion are met.

Either the soil became too salty or too dry for white clover to live. Excess of salt in the soil kills a plant by depriving it of water, and so the effect is the same as lack of moisture in the soil. White clover is perhaps the most shallow-rooted of our pasture-plants and very susceptible

to dry conditions. The summer of 1928–29 being very dry, the heavy Pipiroa soil dried out to a very great extent and the white clover died out completely. The death of white clover of course left the ground more open to the action of the sun's rays and still further drying-out resulted. The rye-grass would be now in a very weak state or dead. The *Porina* caterpillar, being more common in dry climates and in sparse pastures, was apparently encouraged by the suitable conditions prevailing on the weakened pastures, and completed the destruction of the rye-grass. With no vegetation to keep the surface moist, and no

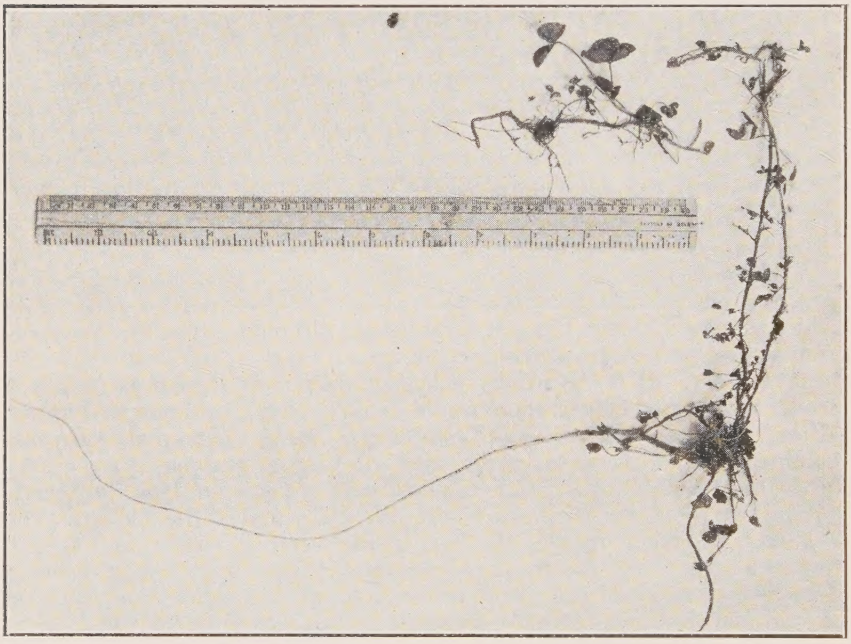


FIG. 9.—A PLANT OF STRAWBERRY-CLOVER (RIGHT) AND A PLANT OF WHITE CLOVER (LEFT) FOR COMPARISON.

Note the length of the root of the strawberry-clover and the short roots of white clover, from the stolon.

live roots to hold the soil together, the ground cracked, making homes for millions of crickets, which cleared up the dead stalks of rye-grass. The result was that on 1,000 acres of land, on which all the rye-grass and white clover was destroyed, all that was left were odd plants of tall fescue, weeds, and patches of *Poa pratensis*, prairie-grass in one or two places, and one small green patch of strawberry-clover. The *Porina* caterpillar was working at the edges of the depleted land now swarming with crickets. Investigators were called in at this stage, and their confusion is perhaps understandable. If they had been able to see the progressive deterioration their job would have been a much easier one.

This patch of strawberry-clover finally showed that what was lacking was a thick permanent sole of clover. Conditions were too dry in many seasons in the summer for white clover, but they were not too dry or too salty for strawberry-clover. Strawberry-clover well established, and the permanent rye-grass soon appears. A thick sole of rye-grass and strawberry-clover, and there is no infestation of *Porina* caterpillar, no cracking of the soil and a home for crickets. Thus what appeared a complex problem is solved.

Success in Transplanting.

The strawberry-clover is extending its range steadily. During the past eight or nine years it has covered about 20 acres of land, mainly by natural means. Every endeavour now should be made to establish this plant all over the remaining 900-odd acres to make it again highly productive. One farmer at Pipiroa, Mr. Scott, has been establishing strawberry-clover by transplanting it in his fields for the past three years. The earliest planted area has now patches of this clover up to half a square chain in extent. At first he took great care in transplanting, and obtained fairly large sods for transplanting. Lately very small sods the size of the palm of one's hand are transplanted successfully. Another farmer has obtained successful establishment with cuttings of stolons placed on the ground when it is moist and simply trodden into the soft earth or mud. The transplanted material establishes itself best in hollows, or in old watercourses where the soil is moist in the summer. During the first year the transplanted strawberry-clover does not spread rapidly, and colonizes in that period about a square yard. After the first year its spread is increasingly more rapid, and it consolidates its position by thickening.

The other method of strawberry-clover establishment is by seeding. Unfortunately the type of this clover frequently obtained from purchased seed is not virile, and although useful, does not compare with the type of strawberry-clover already established at Pipiroa. The seed is also expensive. The clover establishes itself best in hollows or plough finishes, where the soil is moist over the summer. Apparently strawberry-clover before its deep-rooting system develops is less tolerant of dry conditions. Yet when established, in the winter where the soil is poorly drained and wet, strawberry-clover appears unthrifty, and, as previously mentioned, it excels in dry summers.

Before establishment by seed will be advisable some research will have to be made on the productivity of strains of strawberry-clover. There is no doubt that different strains exist, and will be found to vary in yield as markedly as different strains of white clover.

There are thousands of acres of reclaimable marine flats in and around the harbours of North Auckland which are being gradually reclaimed and grassed. For the future safety and well-being of these areas, strawberry-clover should be included in the grass and clover sowings. I hope that, before many of these areas are reclaimed for grassing, investigation will have revealed areas of leafy high-yielding strawberry-clover from which supplies of seed can be obtained.

VERNALIZATION TRIALS WITH WHEAT.

R. THOMSON, Agronomy Division, Lincoln.

VERNALIZATION, devised by T. D. Lysenko (1) at the Odessa Institute of Plant Breeding, is a method involving the pre-treatment of seed to accelerate its development and induce earlier maturity. The subject has received much prominence of recent years. Writing of this method N. A. Maximov(2) says, "The extreme simplicity and yet high efficiency of this method has been demonstrated by the fact that during the current year, 1934, about one million hectares (approximately 2,500,000 acres) have been sown with vernalized seed in U.S.S.R., and yet reports of failure in carrying out vernalization are very rare, even in localities most remote from scientific centres." While reports generally from the U.S.S.R. comment favourably on the method, reports from other centres are more conflicting, varying from records of complete success to failure(3).

The technique for wheat suggested by Lysenko is briefly as follows(1): The seed is moistened with one-third of its weight of water, the water being added in several applications until all has been absorbed. The moistened grain is then spread in layers of from 9 in. to 12 in. deep and allowed to germinate. During this process the temperature should not be greater than 15° C. If it rises, the grain must be spread more thinly, and *vice versa*. When in odd grains the embryo has pierced the seed-coat the temperature is reduced to 3° to 5° C. and held at that for the required length of time. This is given as varying from twelve to fifty days according to the variety. When sowing through a drill, the seeding-rate has to be adjusted to allow for the swollen nature of the grain.

Two possible applications of the practice suggested themselves for New Zealand conditions. On certain of the heavy wheat lands, typically winter wheat country, autumn rains often so delay cultivation that autumn sowing becomes impossible. If by vernalization the growth of a winter variety could be so accelerated to allow of its being spring-sown, this difficulty would no longer exist. In other districts spring sowing following turnips is a regular practice, but often proves disappointing owing to the lateness of sowing. Hastening the maturity by vernalization suggested a method whereby this practice might be rendered more certain.

To test out these possibilities under local conditions experiments with wheat were planned and carried out at the Agronomy Division, Lincoln, during the past season. Four varieties, giving a wide range of maturity were chosen—Hunters and Velvet, both winter wheats; Jumbuck, a spring wheat; and Solid Straw Tuscan, a variety which can be sown with success in either autumn or spring. Lysenko's technique as described above was followed. The moistened grain was germinated in shallow trays and then placed in a refrigerator at 3° to 5° C. for periods of eleven, eighteen, and twenty-five days. These were so timed that all the seed was ready for sowing on the same day. Sowing took place on 7th October. Each treatment was repeated five times for each variety, and untreated controls were included in all plots. There were no significant differences in

germination between the treatments or between the treatments and the controls. In all cases, however, the untreated seed was a day later in coming through the ground.

The relative maturity of the treatments, as indicated by heading dates, is given in Tables I and II for spring and winter wheats respectively.

Table I.—Spring Wheats.

	Jumbuck.		Solid-straw Tuscan.	
	Date Headed.	Days Earlier than Control.	Date Headed.	Days Earlier than Control.
Control unvernalized ..	27th Dec.	..	7th Jan.	..
Eleven days vernalization ..	25th Dec.	2	5th Jan.	2
Eighteen days vernalization ..	23rd Dec.	4	5th Jan.	3
Twenty-five days vernalization	23rd Dec.	4	4th Jan.	3

From the above table it will be seen that both varieties showed a slight acceleration in heading. Threshing-weights revealed no differences as the result of any of the treatments. Grain samples from each of the treatments were similar, those of Jumbuck being very well developed, while those of Solid-straw Tuscan were slightly pinched.

Table II.—Winter Wheats.

In the winter wheats Velvet and Hunters retained their winter habit into February. A count was made on 12th February, when earing was as follows:—

	Velvet.	Hunters.
	Per Cent.	Per Cent.
Control unvernalized	..	2·4
Eleven days vernalization	4·8	5·9
Eighteen days vernalization	8·8	11·2
Twenty-five days vernalization	14·7	18·1

These ears set grain, which, when the experiment was finally examined on 8th March, was in the milky stage.

Further ears continued to appear. These late ears were small and short and mostly empty, although some contained very immature grain. A final count of the total plants in ear was made on 8th March. These figures are given in the following table:—

Table III.

	Velvet.			Hunters.		
	In Ear.	Shot Blade.	Winter Habit.	In Ear.	Shot Blade.	Winter Habit.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Control unvernalized ..	4·0	61·4	34·6	13·6	86·4	..
Eleven days vernalization ..	13·9	75·5	10·6	26·5	73·5	..
Eighteen days vernalization ..	25·3	68·1	6·6	39·5	60·5	..
Twenty-five days vernalization	33·9	61·0	5·1	51·2	48·8	..

SUMMARY.

(1) Vernalization accelerated the earing of spring wheats such as Jumbuck and Solid-straw Tuscan, but the degree of acceleration was slight and insufficient to be of any practical significance under New Zealand conditions.

(2) When winter wheats such as Hunters and Velvet were vernalized and spring sown, the treatment induced a very much higher proportion of ears to develop, but in no case did they reach maturity. Even so, earing was forty-seven days later than untreated Jumbuck.

(3) The percentage of earing progressed with increased lengths of treatment, and it is probable that an even longer period would still further accelerate development.

(4) From these trials vernalization does not appear to have any place in commercial wheatgrowing in New Zealand. Satisfactory spring varieties are already in existence, and in any case the long period of treatment that is necessary would render the practice uneconomical.

REFERENCES.

(1) WHYTE, R. O., and HUDSON, P. S.: Vernalization, or Lysenko's method for the pre-treatment of seed. Bulletin No. 9, Imperial Bureau of Plant Genetics; 1935.

(2) MAXIMOV, N. A.: The Theoretical Significance of Vernalization. Bulletin No. 16, Herbage Publication Series, Imperial Bureau of Plant Genetics; 1934.

(3) Vernalization and Phasic Development of Plants. Bulletin No. 17, Imperial Bureau of Plant Genetics; 1935.

NEW TREE FOR FARM SHELTER.

I. D. BLAIR, Canterbury Agricultural College.

IT is generally admitted that the most useful and desirable type of medium-high shelter is that obtained by growing a combination of rows of *Pinus radiata* and *Cupressus lawsoniana*. Usually two to four rows of pines are planted, with the trees 6 ft. to 8 ft. apart each way, and with one row of *Cupressus lawsoniana* (or *Cupressus Benthamii*) planted 12 ft. to 15 ft. from the pines, with the *Cupressus* trees 4 ft. to 6 ft. apart within the row.

The value of this combination of trees is that the pines are able to provide the high shelter and the lower-growing *lawsonianas* form a dense low line which overcomes the ill effects of the openness between the trunks of the mature pines. Winds which rush through the bare trunks of pines which have lost the lower branches or which have no dense low shelter on one side are probably as severe as where there is no tree-shelter whatever. For low shelter in odd corners or along part of one side of a field *lawsonianas* alone may well be grown in double rows. Such shelter-belts are a feature of many parts of Waikato and are a tremendous asset to those who have been successful in establishing this combination of pines and *lawsonianas* or *lawsonianas* alone.

Throughout the South Island reports are received that it has been impossible to establish belts of *Cupressus lawsoniana*, except on the very best land in the warmer localities of a few districts. To get them to grow at all on the Plains areas one has at least to dig holes and fill these with good soil, in which the *lawsonianas* can then be planted. Even then these trees do not grow well as they approach maturity.

A SPECIMEN OF CUPRESSUS ARIZONICA GROWING AT CANBERRA. IT IS TWENTY YEARS OLD AND ABOUT 25 FT. HIGH, GROWING UNDER CONDITIONS OF A 20 IN. RAINFALL.

All over the Canterbury Plains one can find lines of various species of pines which are quite open at the ground and which thus fail to provide effective stock-shelter. The problem is to find a tree which will grow in association with pines and provide ground shelter in the same manner as *Cupressus lawsoniana* does in Waikato, Taranaki, and Manawatu. *Cupressus macrocarpa* has been recommended for this purpose, but the results, particularly on the drier areas, have not been promising. The branches of *Macrocarpa* grow upright, and unless a trimmed hedge is maintained this tree fails to provide the low shelter.

At Canterbury Agricultural College Professor E. R. Hudson has introduced a new species of cypress which is likely to fulfil the requirements of South Island dry conditions. This valuable addition to our farm-shelter trees is *Cupressus arizonica*, the Arizonian Cypress, the seed of which has been introduced from Canberra.

The Features of Cupressus Arizonica.

The following is an extract from a letter received from Mr. A. E. Bruce, Superintendent, Parks and Gardens Section, Department of the Interior, Canberra :—

"With regard to the qualities of *Cupressus arizonica* as a farm shelter-tree, I should say they were perfect. Its hardiness is unequalled in heat or cold, in dry or wet. There is no other species of Cypress which surpasses it in these respects. Its soil requirements are very easily satisfied, provided good preparation is given to the ground and the position in which it is to be planted. It will withstand any amount of trimming back. We have miles of it used as hedges, kept at a height of 2 ft. 6 in. by 1 ft. 6 in. to 2 ft. wide. The economic value of the tree I cannot comment upon, beyond the fact that its growth here is nearly equal to that of *Pinus radiata*, and I feel sure that the timber is much better in quality than that of *Pinus radiata*—close-grained and very tough. I am of the opinion that you cannot go wrong with *Arizonica* as a shelter-tree, and I believe its growth would be much better with you than with us in our area of 21 in. rainfall."

In the *Agricultural Gazette* of New South Wales, January, 1930, there is the following comment on *Cupressus arizonica* :—

"This species has not been grown to any great extent in this State, but is one of the most widely planted of the Cypresses in South Africa—used for hedges, breaks, and shelter-trees. It does well on a wide range of soils. The lateral branches have a fairly wide spread and provide excellent shelter, a single row being very effective as a windbreak."

It is believed that this tree will prove most useful under South Island conditions. It is certainly worthy of extensive planting under the conditions in which *Lawsoniana* and *Macrocarpa* have failed.

The accompanying photograph of a twenty-year-old specimen of *Cupressus arizonica*, which is 20 ft. high, illustrates clearly the dense, low shelter obtained, the type of shelter which is needed most urgently all over the Plains areas of the South Island.

On a farm in the Ruawai district the value of certified rye-grass is well exemplified. In two fields alongside each other a pasture mixture was sown down four years ago. One was sown with certified rye-grass in the mixture, the other with Canterbury seed, non-certified. The two fields have received practically the same treatment. The paddock in which the certified rye-grass was sown now possesses the desirable rye-grass-white-clover pasture, with sufficient but not too much paspalum. The other possesses little rye-grass, is paspalum-dominant, which grows rank and is inclined to smother the white clover. Thus it appears that on such alluvial clay soils, to obtain that essential type of pasture so desirable and also so highly productive in North Auckland, certified rye-grass must be used.

BLACK-CURRANT-BUD EELWORM IN NEW ZEALAND.

J. MUGGERIDGE and W. COTTIER, Plant Research Bureau.

IN the spring of 1933 a few cuttings from black-currant bushes were received at this laboratory from the Orchard Instructor at Masterton. These were suspected of being infested by the mite *Eriophyes ribis*, which in other parts of the world causes "big-bud" in these plants, the typical condition being an abnormal size in the terminal buds of shoots. A close examination of these buds showed, however, that they were infested by eelworms, in some cases very heavily. In subsequent cuttings received we were unable to find eelworms, and there was a further suggestion that the trouble was caused by Eriophyid mites. Material was sent to England in 1935, but it arrived in too dried up a condition for accurate diagnosis. More specimens received at the laboratory in the early part of 1937 proved again to be heavily infested by eelworms, the symptoms strongly suggesting that the cause of the trouble was the eelworm *Aphelenchoides ribes* Taylor, a pest of black-currant buds hitherto recorded from Britain only, where it was first found in 1917. Material again sent to England was examined by Dr. Goodey, of the Imperial Institute of Agricultural Parasitology, and he found the eelworms present in the buds, in some cases in large numbers. In all cases they proved to be the black-currant-bud eelworm (*Aphelenchoides ribes* Taylor). We have also received specimens of this eelworm on black-currant cuttings from Hastings, Hawke's Bay, but we are unable to say how widespread this pest is in other parts of the Dominion.

SYMPTOMS OF ATTACK.

The presence of infested buds has a great influence on the growth of the wood buds, especially in the spring and early summer. The general effect is to produce a very uneven type of growth, healthy shoots alternating with dead buds (Fig. 1). If infested buds be cut open they will be found to show a more or less extensive black discoloration in the centres.

Taylor (1917) accurately describes the diseased condition as follows:—

"If . . . a shoot known to be infected with worms is kept under observation in the spring, it is seen that the wood buds which have escaped attack will push into growth. These shoots, proceeding as they do from centres of infection, may grow a few inches and then suddenly wilt and die, owing to the worms piercing the delicate tissues of the young stem and destroying the developing leaves. The concentration of the sap in the unattacked buds below such an abortive shoot usually causes several of the nearest unattacked buds on the old wood to break into shoots. These may, if growth is being rapidly made, attain to the length of from 6 in. to a foot. Upon examination of the minute buds they bear it will be found that few have escaped attack . . .

"The terminal buds on such infected shoots are invariably killed, as are many of those immediately below. If all the buds at the apex of those new shoots are successively attacked (and such is a frequent occurrence) the shoot dies back to the nearest unattacked bud. The new basal wood, which considerably influences the yield of fruit in black currants, is similarly attacked and destroyed.

FIG. 1. SHOWING TYPE OF GROWTH CAUSED BY EELWORM INFESTATION. NOTE THAT SOME BUDS HAVE PRODUCED LEAFY SHOOTS, WHILE OTHERS HAVE FAILED TO DEVELOP. NUMBERS OF THESE LATTER HAVE WITHERED AWAY.

[*Photo by H. Drake.*

"Repeated efforts are thus being made by the tree during the growing season to produce new wood, with the result that an irregular growth of twigs is produced about a diseased area. During the resting season no alteration takes place in the growth of the tree, but the worms continue to destroy the buds. In the spring long lines of unexpanding buds, interspersed with a few which are developing normally, show the effect of the activity of the worms during the months when the trees remain dormant.

"The irregularity in the growth of the wood is most characteristic of an eelworm attack, and the presence of dead or partially dead shoots, with the bark shrivelled, the end tapering and thread-like, together with a cluster of weak shoots, are typical signs of the presence of the black-currant eelworm."

The Causal Organism and its Habits.

The eelworms are very minute in size, not discernible as such to the naked eye, and their true nature can be made out only under magnification. When infested material is teased up with water and viewed through the microscope the colourless and more or less transparent worms appear as in Fig. 2. When adult the worms are approximately 1 mm. long. In infested buds all stages from the egg up to the fully-grown adult are present.

According to Taylor (*loc. cit.*) the worms enter the buds through the spaces between the scale-leaves. They either remain feeding amongst the scale-leaves or else pass on to the inner and true leaves. In the first case, the scale-leaves themselves being more or less unattractive for feeding, the eelworms congregate at the base of them and feed on the succulent tissue there. The damage done to these parts results in the decay of this tissue and the water and food supply being thus cut off from the buds these structures die and decay, the worms subsequently multiplying in the decaying material. When the true inner leaves of the bud are attacked the tissues there are discoloured and finally destroyed. The eelworms do not feed internally in the tissues of the bud-leaves, but live ectoparasitically between them.

When a bud has been destroyed the worms migrate to adjacent buds either above or below the one they have left. For this they require the presence of films of moisture on the stems, and migration is entirely dependent on the presence of such conditions produced by rain, dew, &c. Having reached healthy buds the worms quickly set to work to destroy them in turn.

The time taken to destroy buds varies with the state of growth these are in. In the spring, when the new buds are very small, they are killed rapidly, but later on when the buds are freely developed they can remain alive much longer.

The worms are at work in buds all the year round, but in the springtime they seem to be most active, and this is the time of the year when most reproduction is going on.

Under dry conditions the worms can exist in a dessicated but live state for several months, so that in cases where they have killed buds and are ready to migrate, but are unable to do so on account of the dry state of the bushes, they will assume this dessicated resting condition. As soon as sufficient moisture is present they will revive, however, and take on active movement again and are quite able to migrate to adjacent buds and multiply there.

Dispersion.

The eelworm can be disseminated by striking cuttings containing infested buds and very probably by the handling of healthy bushes and infested ones in turn, such as is bound to occur in pruning

operations. This dissemination would be much more effective if the bushes were handled or pruned when they are moist. Heavy rains can wash or splash migrating worms from one stem to another or on to the ground whence they can crawl in the moisture films to other bushes. When the worms are in a dessicated state washing off by rain and splashing to adjacent parts is all the more easy, as in the dried condition they float very easily on the surface of the water. It is also suggested that wind may play a part in spreading worms, as in dry weather dead buds dry up rapidly and the scale-leaves quickly become brittle and are broken off and carried away by the slightest movement, taking with them colonies of dessicated worms in a quiescent condition.

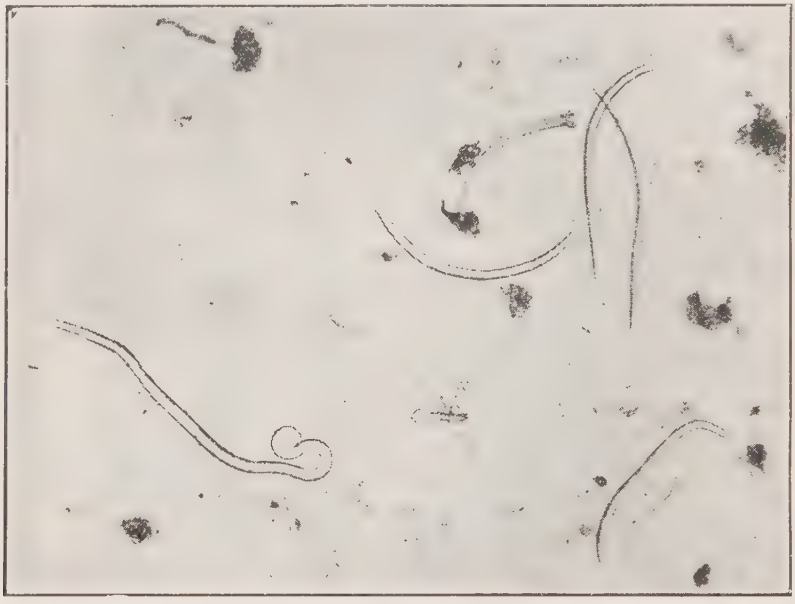


FIG. 2. PHOTOGRAPH THROUGH THE MICROSCOPE SHOWING TYPICAL INDIVIDUALS OF THE BLACK-CURRANT EELWORM. × 70 (APPROX.).

CONTROL.

As far as the writers are aware, no work has been done on the control of this particular pest in any part of the world. Recent correspondence with the Imperial Institute of Agricultural Parasitology in England has shown that English authorities agree that possible remedies can only be suggested and that nothing positive can be asserted. It would seem that possible means of control might be along the following lines, and this is all that can be put forward to growers at the present time :—

(1) The use of sprays and chemical dips.
(2) Hot-water treatment of one- to two-year-old plants in the nursery before placing out in permanent beds.
(3) General hygienic measures.

The above methods are suggested from a consideration of those measures that have been adopted for closely related plant parasitic eelworms—*e.g.*, the chrysanthemum eelworm (*Aphelenchoides ritzema-bosi*). There seems no reason to suppose, provided the worms can be reached, that the black-currant-bud eelworm cannot be killed by treatments that control such closely related species.

(1) *Use of Sprays and Chemical Dips.*—Sprays at best have been found to be a doubtful quantity and only partially successful against this type of eelworm. Goodey (1933), in discussing the position with regard to chrysanthemum eelworm, states that a thorough investigation of spraying-materials tried has shown that most of them are useless. This is the case with sulphur and copper compounds, potassium permanganate (Condy's crystals), barium chloride, picric acid, sodium carbonate, limewater, mercury, arsenic, and nicotine preparations in soft-soap solutions at concentrations harmless to the plant. The only material which might offer some promise of success is a 3-per-cent. solution of ammonia. This has been used by some workers on chrysanthemums without injuring the plants, and favourable results have been claimed in killing the worms. The difficulty with spraying for black-currant-bud eelworm will be to reach the worms that are hidden between the bud-leaves. It seems that the best that can be hoped for is a kill of those worms that are caught in the act of migrating from one bud to another, and this will provide relief but not cure. It is suggested that those who might wish to try a spray would be well advised to try the ammonia solution, using ordinary ammonia 3 parts to 100 parts of water. At first use the spray carefully on a few bushes only, as it is not known what the effect of the spray on black currants will be. It can be readily understood that frequent sprayings at regular intervals will be required, as the idea is to catch the worms as they are migrating.

Since this migration is going on at all times, spraying will theoretically bea dvisable throughout the year, but the most important period will be in the spring, when the bushes are beginning to shoot.

Miles (1935) says that in certain quarters it is claimed that dipping chrysanthemum-cuttings in a potassium-sulphocarbonate solution will rid them of eelworms. However, it is not yet accepted as a proved case, but if the chemical will kill chrysanthemum eelworms where the worms are actually within the tissue, it is considered reasonable to suppose that it will also kill black-currant eelworms where the worms live between the bud-leaves and not actually within the plant-tissue. It may be worth while to try dipping black-currant cuttings in the solution prior to striking. The dip is prepared by dissolving ½ lb. potassium sulphocarbonate in 3 gallons of water in which ½ lb. of soft soap has been dissolved. Soak the cutting in this for one hour.

(2) *Hot-water Treatment.*—This method is drastic on most kinds of plants and could be tried, of course, only on young black currants before they are put out into permanent beds. In all likelihood hot-water treatment of unrooted cuttings would result in the death of all cuttings treated, and it is necessary that they should have been struck and grown a strong root system before being immersed

in the hot water. After a consideration of the available information it would seem that only young plants one or two years old could be submitted to hot water at a temperature of 110°–112° F. for thirty minutes. Do not immerse the roots, and to prevent their drying out wrap them in damp cloth. For success it is necessary to keep the temperature constant within the limits set, and to do this without a thermostatically controlled bath might be laborious, especially considering that the volume of warm water might be necessarily fairly large. To keep down the volume of water it would be advisable to prune back the young bushes as hard as possible before treatment. To carry out the treatment successfully it is necessary that the thermometer used should be accurate and the source of heat must be such that it can be controlled satisfactorily. If young bushes with strong rooting-systems are used, pruned back and with their branches tied in a bunch to conserve space, it should be possible to carry out the treatment with reasonable efficiency. Hot water is very effective in killing eelworms, and although it is usually drastic on plants one can be satisfied that if the treatment is carried out properly there is little chance of survival of the pest. Treatment must be carried out in the dormant season. No experimental work has been carried out to discover the effect of hot water on the subsequent growth of black-currant plants, and growers are advised to proceed cautiously until something more definite can be put forward.

(3) *General Hygienic Measures.*—On established plants in permanent positions in black-currant beds it seems that little can be done beyond cutting out and burning all infested parts and periodically spraying with the ammonia solution described above, if such should prove suitable for application to black currants. A careful watch should be kept at all seasons of the year for signs of eelworm attack, and all shoots bearing any signs of weak or dead buds or any other suspicious symptoms should be carefully removed and burnt. Especially in the spring is it necessary to keep a careful watch, and all branches bearing weak and spindly growth from buds should be promptly cut out. Handling of any kind such as is necessary in pruning should not be done unless the bushes are dry. If such operations are carried out under moist conditions it can readily be understood from what has gone before how easy it would be to transfer worms from one shoot to another or from one bush to another. Do not leave prunings on the ground, as worms can migrate from these to adjacent healthy growth, especially to underground shoots. Gather up all cut pieces and destroy them. When putting out new plants be careful to place them well away from infested bushes.

Hygiene demands the avoidance of indiscriminate handling at all times, and these measures and the cutting-out of all suspected growth will help greatly to check the spread of the eelworm.

Acknowledgments.

The writers are indebted to the Imperial Institute of Agricultural Parasitology in England for the identification of the black-currant-bud eelworm and also for various suggestions on possible control methods.

LITERATURE CONSULTED.

(1) GOODEY, T.: Plant Parasitic Nematodes and the Diseases they Cause. Methuen and Co., Ltd., London. 1933.
(2) MILES, H. W., and M.: Insect Pests of Glasshouse Crops. H. C. Long, Surrey, England. October, 1935.
(3) TAYLOR, Miss A. M.: Black Currant Eelworm. *J. Agric. Sci.*, Vol. 8, Part II March, 1917, p. 246.

PREVENTION OF FROST DAMAGE IN ORCHARDS.

VISIT TO WESTERN STATES OF AMERICA.

W. R. LLOYD WILLIAMS, Orchard Instructor, Alexandra.

IT may safely be stated that preventive measures against frost damage with fuel oil as the heating medium were commenced commercially in New Zealand orchards as a result of the destructive spring frosts of 1926 in Central Otago. The writer, arriving in the district a few days after the visitation, was convinced that it was one of the major problems. Contacts were immediately made with authorities in California, notably Mr. W. R. Schoonover, with whom an intermittent correspondence has since been carried on, with great benefit to the industry here. The deciding factor to growers was the initiation of an experiment in orchard-heating financed by the Department of Agriculture. The experiment was conducted by the writer with lard-pail heaters burning oil at the orchard of Mr. W. Bringans during the springs of 1927 and 1928. Annually the area protected in Central Otago was slowly but steadily increased until 1933, when another disastrous frost occurred, after which the area protected was increased more rapidly.

Last spring, 1936, certain areas in Central Otago were again considerably damaged and, in addition, injury was caused over a large area in Hawke's Bay. As a result of these all-too-frequent occurrences a large number of growers who had not previously used protective measures desired to acquire equipment, but before incurring the expenditure that this would entail, an expenditure which many growers in consequence of their periodically reduced crops and low fruit prices could ill afford, it was felt that the industry should be in possession of the latest information on the subject. To this end the Government was asked to allow a departmental officer to visit the Western States of America and investigate the methods employed in this connection. As a result I was deputed to proceed to Oregon and California, via Vancouver, leaving Auckland on 20th April " for the purpose of investigating the latest methods adopted in that country by way of protecting fruit crops, particularly deciduous fruit, against frost damage." As it was considered necessary to bring back the information in time for the coming season's danger period, the visit was limited to a return to New Zealand by the end of June.

Time was spent with officials and growers in the deciduous orchards of Medford (Oregon), Wenatchee and Yakima (Washington), and Southern California, also the citrus-groves of the latter State, and contacts were made with the leading authorities on frost-prevention work, including those of the Departments of Agriculture and at the California University and its experiment stations at Riverside and Davis.

There is no doubt that frost-prevention is a very important factor in orchard-management in certain fruitgrowing areas, and it is equally true that where standard methods have been efficiently applied a satisfactory measure of success has been achieved.

Two Main Principles.

The two main principles involved in frost-prevention are (*a*) prevention of heat-losses and (*b*) addition of heat. The former method is practised to a limited extent in the form of screens of various sorts, such as scrim, paper, &c., soiling-up of low-grown crops, and water vapour. Smoke, including chemical smoke or screens as used in the war, has been proved of no value except for the very lightest frosts. Glasshouses are a good example of the prevention of heat-losses.

In orchards the most popular methods are by adding heat in some form or another. Undoubtedly the fuel in most general use for orchard heating, whether for deciduous or citrus, is a marine Diesel oil, similar to that in use in New Zealand, but somewhat more refined. The "lard-pail" type, or "smudge-pot" as it is generally called, is the most generally used oil-burner for deciduous fruits. It is emphasized by the best authorities that, except for the smoke and soot nuisance, these heaters give as satisfactory, and usually cheaper, results for oil-burning as any on the market, including the much higher-priced types. Larger pots are mostly used without flame spreaders and they are spaced farther apart than in New Zealand. This method certainly reduces labour, but the writer was advised that our method was safer under our conditions, especially if the inversion is poor, as is often the case on the first night of a series of frosts.

More expensive equipment, such as high and low stack heaters, and those fed through piping reticulated through the orchard from a central storage tank, are only used in deciduous orchards to a limited extent. Millions are in use in the citrus groves on account of the longer burns necessary in winter time and, when properly used, of their almost complete smokelessness.

Solid fuels are also used with success in some orchards, the favourite being petroleum-coke, a production of gasoline "cracking" plants. Considerable improvements have recently been made in solid-fuel heaters, improved draught is available and fires can be extinguished by a device which excludes the air.

Other methods of orchard-heating were also investigated.

Electricity Impracticable.

Electric heating is entirely impracticable on account of the enormous amount of electricity required to heat even a small orchard.

Air-circulators, or wind-machines, with large propellers for mixing the upper warm air with the lower cold air, and later models with furnaces burning oil attached, were seen.

A liquid-petroleum gas piped throughout the orchard from a reservoir burns a propane-butane combination.

An example of central heating of orchards with hot air was investigated. It consists of two small brick furnaces which are supplied with a mixture of oil and air through burners on the side. Fans draw off the heated air and discharge it into two mains, which feed cross laterals

along each row. In these laterals are holes for the warm air to circulate through the trees. The outfit has proved successful over a number of years.

Thermometers and frost alarms were looked into and the degree of damage done at different temperatures at varying stages of growth. Considerable work has been done by officers of the United States Weather Bureau in this connection, and until we create our own table of damaging temperatures we must avail ourselves of their figures as a basis. Much, however, needs to be done to co-ordinate these temperatures with our own, the first step being to improve and standardize the type of thermometer shelters in use in New Zealand orchards.

Up to the abnormal frosts of January, 1937, in the citrus areas of California, it may be said that for a number of years the principal avenue for official research energy and money into frost-prevention methods was in the direction of improving the types of oil-burners, in obtaining greater heat, in improving combustion, and, as a result, combating the smoke nuisance—the latter especially appearing to be the main goal. Much has been done in this direction ; new and better types of burners have been evolved and improvements made to old ones, resulting in an appreciable lessening of the smoke nuisance. Consider the extent of the oil industry, the cheapness of this fuel, and its comparative ease of transport and use, the capital sunk into plant established for the manufacture of the present type of burner and into the millions of these oil-burners in stock in the orchards, and it can be appreciated why research has not materially extended into wider fields. Great work has been done in this connection by the Engineering Branch of the Davis Experiment Station of the University of California in conjunction with Mr. Schoonover and others. Intensive research is now taking place into new methods. The first big preliminary move is a complete survey of orchard-heater performance by means of answers to a comprehensive questionnaire taken by officers from every person using frost-prevention appliances.

It is impossible to estimate the value of the services of the small band of specially trained United States Weather Bureau men, under Mr. Floyd D. Young, who constitute the Fruit Frost Service. Men are stationed in various districts during the danger period and broadcast the necessary information. Growers depend wholly on these forecasts for orchard heating.

Summary.

Smoke is of no practical value for frost-prevention.

Water is of use only in light frosts and in cases of emergency.

Electricity is too expensive.

Air-circulation has not proved satisfactory, and is very costly. Newer types, which will be still more costly, are being tried.

Lard-pail oil-heaters are still equal to any other type for deciduous fruits.

Tall stack oil-heaters are too expensive for our use.

Low stack oil-heaters will eliminate the smoke nuisance at a reasonable cost.

Liquid petroleum-gas (propane-butane) is too costly to install and maintain in this country—supplies are not dependable and the material very inflammable.

Hot air (central heating) has proved satisfactory in the one instance investigated. It is costly to install, but very cheap and clean to run.

Coal, coke, wood, &c., are used in cases of emergency only.

Carbon briquettes are not much used. Supply not dependable.

Petroleum coke briquettes are the most satisfactory solid fuel.

Coal briquettes, if used with proper heaters, should prove quite satisfactory, and if the prices of heaters and briquettes are reasonable will probably prove cheaper than oil. Also makes use of a New Zealand product. With a view to obtaining a more complete combustion the use of nitrate of soda or similar agent in the manufacture of bricketts such as is being experimented with elsewhere should be worthy of a trial in New Zealand.

Thermometers and alarms must be tested and be accurate to a half degree.

Thermometer shelters of a more standard type are required. Research into damaging temperatures is needed.

This opportunity is taken to sincerely acknowledge the really extraordinary assistance given by all with whom contact was made. This is especially true of all officers of the Departments of Agriculture and Universities of the States visited, United States Extension officers, and Fruit Frost Service men. Nothing appeared to be too much trouble, no distance too far to travel, no information too hard to obtain, to make the results of the visit successful.

SUGAR BEET AS A PIG FEED.

A CROP of sugar beet grown on the Waimate West Demonstration Farm for the purpose of beet-sugar investigation is creating interest as a feed for pigs.

It is the usual farm practice to winter store pigs in open, small, grass paddock runs, with a ration of mangels, carrots, and whey.

This year, however, root-growing is confined to the above area of sugar beet, with the exception of a very small area of carrots.

A start was made in feeding sugar beet to the pigs during May last, and although at the commencement a few carrots were fed out with the beet the pigs selected and ate the sugar beet prior to the carrots.

The Manager states that the pigs are particularly partial to sugar beet, and he has never had pigs to winter and thrive so well. A total of twenty-two store pigs and one sow with a litter of nine are being regularly fed with sugar beet. The total amount fed in conjunction with whey is from 65 lb. to 75 lb. per day, and the grass run area is approximately 1½ acres.

The beet is lifted, leaves topped, and allowed to ripen some ten days prior to feeding.

Experience to date is such that sugar beet presents possibilities as a valuable pig feed.

—*J. E. Davies, Hawera.*

A combination of subterranean clover and swedes was noted in the Apiti district. The growth of the clover was very strong, making a dense cover between the rows, even though suffering slightly from some of the exceptionally heavy frosts experienced in the district. The subterranean clover was sown in mistake for chou-moellier seed, and the evidence noted from the mistake makes it appear as if it might be a combination worth consideration.

INVESTIGATION OF THE RELIABILITY OF THE "PICRIC-ACID TEST" FOR DISTINGUISHING STRAINS OF WHITE CLOVER IN NEW ZEALAND.

N. R. FOY, Seed Analyst, and E. O. C. HYDE, Assistant Seed Analyst.

IT is a matter of common observation that the individuals comprising a species, while showing a necessary degree of conformity to the specific type, display many inherent variations. Because of this variability it is possible by intelligent selection to obtain the more valuable strains from a useful species. This selection of superior strains has been carried out with great thoroughness with many species of plants, but it is only of recent years that the work has been undertaken in a systematic manner with our pasture plants.

Trifolium repens, or white clover, the most important leguminous species in our pastures, has proved a very profitable subject for this work of strain-selection. Davies and Levy(2) have made a study of this species in New Zealand, separating local strains and comparing them with others from Europe.

The characteristics to which attention was mainly devoted were :—

(1) Capacity for herbage production.
(2) Seasonal fluctuations in herbage production.
(3) Ability to persist under grazing and competition with other pasture plants.

On the basis of variation in these properties it was found possible to group the different forms of white clover under six types, the occurrence and uses of which they have described.

Davies and Levy report that the best New Zealand strains are excellent in all respects for permanent pasture of fertile land. The capacity for herbage-production is high, and production is maintained at a relatively high level during the critical periods in summer and winter. Plants of these strains are also well adapted to survive and produce herbage abundantly in mixed pastures of vigorous growth.

The poorer strains have a relatively low capacity for herbage-production. They show great seasonal fluctuations in production, there being little growth in late summer and winter. Furthermore, these strains of white clover are incapable of persisting in a pasture where there is little opportunity for regeneration from seed.

After making an intensive survey Davies and Levy reported that in about one-tenth of the white-clover-seed crop of New Zealand the best strains were found to preponderate. Six-tenths of the crop was of a poor strain, but little better than the bulk of the European seed imported into New Zealand. In about three-tenths there was an admixture of good and inferior strains.

A need was felt for some reliable means whereby the strain represented in a line of white-clover seed might be rapidly determined. Work was undertaken by the Department of Agriculture with a view to solving the problem. The present article records the results of an investigation by the Seed-testing Station of the possibilities of a chemical test for distinguishing the strains of white clover at an early seedling stage.

Review of Literature.

It has long been known that the tissues of some plants contain small quantities of a glucoside which, under certain conditions, as when the tissue is crushed, is broken down by associated enzymes, one of the products of this decomposition being hydrocyanic acid gas or prussic acid (HCN.)

The presence of a cyanogenetic glucoside in wild white clover was first reported by Mirande(5) in 1912. The occurrence of the glucoside in white-clover plants of various origin was investigated more fully by Pethybridge(6) using Guinard's test for detecting the evolution of HCN from seedlings. It was found that seedlings of the strain "Kentish wild white clover" invariably gave a positive reaction, while most samples of ordinary cultivated white clover of English origin gave a negative result. Sampson(7), using the same technique as Pethybridge, found that of fourteen samples of New Zealand seed, all produced cyanaphoric seedlings.

Doak(3) in 1933 reported the results of a very thorough investigation of the occurrence of the cyanogenetic glucoside in New Zealand white clover. Quantitative determinations were made of the amount of HCN present in herbage from plots and from individual plants. It was shown that the HCN content of herbage from plots established from different lots of New Zealand seed varied over a wide range—namely, from 10 parts per million to 130 parts per million. Furthermore, it was shown that there existed a high measure of correlation between HCN content and strain. Plots classed as "mother seed" showed a hydrocyanic-acid content of 70 to 130 parts per million; plots classed as "permanent pasture," 30 to 70 parts per million; rejected plots, 10 to 30 parts per million.

Material.

The seed used in the present investigation comprised some seven hundred samples which had been used by the Agrostologist to establish plots for strain trials. The seed was all of New Zealand origin, and each sample was representative of the crop from a single known field. Since most of the samples came from old pastures and had been submitted for plot trial to determine whether the seed was eligible for certification, the material was, on the whole, above average quality.

Methods.

In the present studies the technique described by Pethybridge(6) was employed with minor modifications. Seedlings were prepared for the test by growing them from seed for eight days in diffused daylight in an incubator of the Copenhagen type. Into each of four small test tubes fifty seedlings were lightly crushed. Two or three drops of toluene were then added to kill the tissues and prevent decay. Into each tube was then suspended a strip of filter paper $2\frac{1}{2}$ in. long by $\frac{1}{4}$ in. wide. To prepare this paper sheets of filter-paper were dipped into a solution of 1 part of picric acid and 10 parts of anhydrous sodium carbonate in 200 parts of distilled water. The paper was then cut into strips and was stored and used in a moist condition. The tubes were sealed with rubber stoppers, numbered, and placed in an incubator at 30° C. for forty-eight hours. If present, the cyanogenetic glucoside is hydrolysed under the influence of the appropriate enzymes, and the gaseous hydrocyanic

acid is liberated. This gas, reacting chemically with the substances in the filter paper, forms a compound which gives the paper a reddish-brown colour. In this way the presence of quantities of hydrocyanic acid may be detected. The intensity of the coloration of the paper depends on the amount of hydrocyanic acid liberated, and thus it is possible to determine colorometrically the relative amounts of hydrocyanic acid produced by different samples. An arbitrary scale of colour shades was established which divided the material examined into seven groups. The colour shade at the points dividing the groups were fixed by preparing a series of colour standards.

Several series of experimental tests were conducted to determine what factors might be capable of causing variation in the intensity of the reaction. It was observed that the temperature at which the tubes were incubated was a matter of importance. The greatest intensity of reaction was produced by incubation for forty-eight hours at 30° C. At room temperature the coloration of the paper was distinctly lighter, while at a temperature of 10° C. only a faint reaction was obtained after prolonged incubation of highly cyanophoric material. The moistness of the paper strips was also found to be important. If the paper was too dry the intensity of the reaction was reduced. On the other hand, moderate wilting of the seedlings and also the failure to add toluene to the crushed seedlings in some instances produced no perceptible difference in the reaction. When reasonable care is taken in preparing the material and carrying out the tests there is rarely any considerable variation among a number of tests of one sample.

It has been stated already that the white-clover seed samples used in this investigation were at about the same time subjected to plot trial by the Agrostologist and classified according to the standards employed in the seed-certification scheme in operation at that time. Seed was approved for certification when the better types—namely, types 1 and 2—predominated in the plot. Most of these samples also contained some of type 3. The best samples containing a large proportion of type 1 were classed as mother seed (M.S.); while the others were classed as permanent pasture (P.P.). The samples of inferior quality, composed largely of type 3, were classed reject (R.).

Results.

During the year 1935, 463 samples of seed for which final plot trial reports had been made available were submitted to the test. Table I summarizes the results. It will be seen that there is a high measure of correlation between the grading on plot trial and the classification based upon the "picric acid" test. In other words, a high positive correlation between agronomic quality and cyanogenetic glucoside content is demonstrated. Doak(2) has shown that a similar measure of correlation exists between the hydrocyanic-acid content of herbage and the quality of the strain.

"Mother seed," samples of which there was a total of 66, fell almost equally into Classes 5 and 6, and none fell below Class 5.

Samples placed in the "permanent pasture" grade by the plot trial were predominantly of Class 4, although some are found as high as Class 6 and others as low as Class 2. Twenty-nine samples out of a total of 181 in this group fell below Class 4.

All of the 216 samples rejected on plot trial fell below Class 4.

During the year 1936 comparative tests were carried out on a further group of samples. The experience gained during the previous year's work, together with information obtained from experiments conducted with a view to improving the technique, made it possible to produce more consistent and reliable results than was possible the previous season.

Table II summarizes the results obtained for the 234 samples tested during the past year and demonstrates again the strong positive correlation between the grading by plot trial and the classification based upon the intensity of the reaction in the chemical test. The position is closely parallel to that shown in Table I. The principal differences are as follows: The proportion of "mother seed" samples falling in Class 6 is considerably greater. The proportion of "permanent pasture" samples falling into Class 6 under the chemical test is much smaller, there being only one such in a total of 126. Finally, a small proportion of the samples rejected on plot trial (4 in 90) fell into Class 4 under the chemical test.

In Table III an analysis is made of the samples of each certification grade. The left-hand column gives the composition of the lines in terms of the types to which allusion was made in the introductory section of this article. The groups are arranged according to the predominance of the superior types of plant.

It will be observed that in "mother seed" samples the type 1 predominates, while in the rejected material type 3 predominates. Among samples of the "permanent pasture" grade those showing a higher content of type 1 give a stronger reaction under picric-acid test than do those which comprise largely the lower types.

The relative HCN content of types 2 and 3 is a matter of interest. The present data do not, however, throw much light on this question. A comparison of the distribution according to chemical reaction of samples with a type composition of 2 plus 3 and 3 plus 2 respectively, and again those samples with a type composition of 2 plus 3 plus 1, and 3 plus 2 plus 1 respectively, indicates that type 2 is more highly cyanophoric than is type 3.

Use of Picric-acid Test in the Certification of White-clover Seed.

Since the commencement of the present year the picric-acid test has been used by the Department of Agriculture as the basis of qualification of white-clover seed for the purposes of certification. Lines falling into Class 6 under the test qualify for the "mother seed" grade. Lines falling into Classes 4 and 5 are included in the "permanent pasture" grade. Other lines giving a lower reaction are rejected from certification.

To define the grades "border-line" control, samples are included with each batch of samples tested. A Lovibond tintometer has been found of some assistance in comparing with the controls tests which lie closely to the border-line. When this instrument is used the colouring-material is leached from the paper strips

with a measured quantity of water, and the samples then compared on the basis of the intensity of the red element in the colour of the solution.

An examination of Table III will show what changes may be expected to result from the change from the plot trial to the chemical test as the basis for the certification of white clover. Of the eighteen lines passed as mother seed on plot trial, thirteen would be so classed by the chemical test and the remaining five are placed in the permanent-pasture grade. Of these five, four have a type constitution of 1 plus 3.

Only one in a total of 126 P.P. lines would be raised to the mother-seed grade, and this line is predominantly of the type 1.

Eighteen of the 126 P.P. lines (14 per cent.) are rejected from certification by the chemical test. Of these, thirteen, or over two-thirds, are composed of type 3 plus type 2.

Of ninety lines rejected on plot trial, all are rejected by the chemical test, except four, which fell in Class 4, and are thus graded P.P.

With twenty-eight lines out of a total of 234 (12 per cent.) differences occur in the grading by plot trial and by chemical test. On the other hand, there is agreement in 88 per cent. of the lines.

Table I.—Summary of Results from Samples studied during 1934, showing Correlation between the Classification by the Picric-acid Test and the Classification by Plot Trial.

	Classification by Picric-acid Test.							Total.
	6.	5.	4.	3.	2.	1.	0.	
Grading by plot trial—								
M.S.	34	32	..	..	..	..	..	66
P.P.	8	60	84	20	9	..	..	181
R.	..	..	..	90	62	64	..	216
Total ..	42	92	84	110	71	64	..	463

Table II.—Summary of Results from Samples studied during 1935–36, showing Correlation between the Classification by the Picric-acid Test and the Classification by Plot Trial.

	Classification by Picric-acid Test.							Total.
	6.	5.	4.	3.	2.	1.	0.	
Grading by plot trial—								
M.S.	13	5	..	..	..	..	..	18
P.P.	1	27	80	15	3	..	..	126
R.	..	..	4	48	25	10	3	90
Total ..	14	32	84	63	28	10	3	234

Table III.—Summary of Results from Samples studied during 1935–36, showing Correlation between Type Composition and Classification by the Picric-acid Test.

M.S.=Mother seed; P.P.=permanent pasture; R.=rejected.

Type Composition.	Certification Class.	Classification by Picric-acid Test.						Total.
		M.S.	P.P.		R.			
		6.	5.	4.	3.	2.	1 + 0.	
Classification by plot trial—								
1	M.S.	1	..	..	..	..	..	1
1+2	M.S.	4	1	..	..	..	..	5
1+3	M.S.	8	4	..	..	..	..	12
1+3	P.P.	1	3	3	..	..	..	7
1+2+3	P.P.	..	1	1	..	..	..	2
3+1	P.P.	..	2	8	1	..	..	11
2+1+3	P.P.	..	1	5	..	..	..	6
3+1+2	P.P.	..	2	1	..	..	..	3
2+3+1	P.P.	..	9	18	1	..	..	28
3+2+1	P.P.	..	1	10	..	1	..	12
2+3	P.P.	..	8	16	1	1	..	26
3+2	P.P.	..	..	18	12	1	..	31
3+2	R.	..	..	..	5	5	2	12
3	R.	..	..	4	43	20	11	78
Total ..	..	14	32	84	63	28	13	234

Acknowledgments.

The writers wish to acknowledge the generous assistance of Mr. E. B. Levy and Mr. L. W. Gorman.

They are also indebted to Mr. B. W. Doak for advice regarding the technique of the chemical tests.

References.

(1) Adams.
(2) Davies, Wm., and Levy, E. B.: Strain Investigation of Grasses and Clovers. *N.Z. Jour. of Agric., 42*, 75–89, and 151–164; 1931.
(3) Doak, B. W.: A Chemical Method for the Determination of Type in White Clover. *N.Z. Jour. Sci. & Tech., 14*, 359–365; 1933.
(4) Levy, E. B., and Gorman, L. W.: Strain Investigation of White Clover. Part I, *N.Z. Jour. of Agric., 46*, 78–89, 1933; Part II, *Ibid.*, 49, 86–104.
(5) Mirande, M.: Comptes rendus Acad. Sci., Paris, 155, 651; 1912.
(6) Pethybridge, G. H.: Is it Possible to Distinguish the Seeds of Wild White Clover by Chemical Means during a Germination Test. *Econ. Proc. Roy., Dublin Soc., 2*, 248–258; 1919.
(7) Sampson, K.: Cyanophoric Tests with Seedlings and Plants of White Clover. Welsh Plant Breeding Station Bull. Series H., No. 1, 70–73; 1922.

The value of suitable top-dressing to induce clover-growth in pastures, particularly paspalum pastures, is to be observed in North Auckland. Right through the winter where such conditions exist the clover has stimulated the paspalum, and this grass has produced feed right through, whereas paspalum pastures lacking clover are yellowish and are making no growth.

NEW-ZEALAND-RAISED SWEET ORANGES.

A. M. W. GREIGG, Orchard Instructor, Auckland.

THE search for a New Zealand sweet orange equal in all respects to imported fruit is the aim of every keen citrus-grower in this country. Whereas one may advocate heat, another the rootstock, soil, or various climatic conditions as the limiting factors, there is one strong advocate for the New Zealand Poorman's orange—he is Mr. Fred. Lippiatt, of Luke Street, Otahuhu. Mr. Lippiatt is a firm believer that the best prospects of obtaining the desired fruit are to be secured from Poorman's sports, specially selected budwood from the better class of tree or the cross-pollination of Poorman's trees with sweet oranges.

Confusion is still apparent in the minds of people as to the difference between New Zealand Poorman's orange and New Zealand grapefruit. There is none other than in quality. An orange-tree imported from India and grown by the late Sir George Grey at Kawau Island bore such a crop of fine oranges, although with a distinct flavour, that the remark was passed, "That's a poor man's orange." Budwood from this tree established the New Zealand Poorman's orange throughout the country. During recent years grapefruit has become popular, especially in the United States, and the suitability of the New Zealand Poorman's orange for grapefruit purposes induced a local firm to popularize the fruit under the name of New Zealand grapefruit. Only good, well-matured fruit should ever be marketed under this name, otherwise the old prejudice against the Poorman's orange will again have to be lived down.

Mr. Lippiatt has held the belief for forty years that a sweet orange adapted to New Zealand conditions could be evolved from the New Zealand Poorman's orange, but it is only during the last ten years that he has started to put that belief into active practice. The New Zealand Poorman's has proved itself a powerful grower and heavy cropper under a wide range of conditions, but hybridization towards an improvement in flavour is necessary in the effort to obtain a New Zealand sweet orange. Mr. Lippiatt appears already to have evolved a sweeter fruit, which, even though it cannot yet be classified as a sweet orange, should improve the demand for New Zealand grapefruit, as according to an authority, Mr. Harvey Turner, fruit-merchant, of Auckland, a sweeter fruit was desirable for the New Zealand grapefruit trade, and Mr. Lippiatt's seedling appears promising for that purpose.

HISTORY OF SEEDLING.

The history of Mr. Lippiatt's seedling, although not a direct outcome of his theory of a sweeter Poorman's orange, yet throws an interesting light upon the history of the New Zealand Poorman's.

About ten years ago a citrus-grower named Mr. T. W. Hewett, of Aitutaki, Cook Islands, used to market his fruit through the firm of Messrs. Turners and Growers, Auckland. On visiting the markets one day Mr. Harvey Turner directed the attention of Mr. Fred Lippiatt, of Otahuhu, to a very fine grapefruit from a case of mixed fruit sent Mr. Turner from Aitutaki. At lunch that day Messrs. H. Turner,

S. Thompson, F. Lippiatt, and J. W. McMicken sampled this grapefruit, and all were impressed by its fine qualities—large, 8 in. in diameter, thin-skinned, similar in appearance to an Island orange, and very juicy. Mr. Lippiatt was so impressed that he insisted upon taking all the seeds home and planting them there. From the fifteen

TREE RAISED FROM ONE OF MR. LIPPIATT'S ORIGINAL IMPROVEMENT POORMAN'S SEEDLING TREES, SHOWING THE WAY IN WHICH THE SEEDLING HAS GROWN EVEN WHEN PLACED ON A STRONG STOCK. THE BUD IS THE RIGHT-HAND GROWTH, AND THE STOCK THE LEFT.

seeds he obtained sixteen seedlings. Obtaining more seedlings than seeds planted is fairly common in citrus and is due to the phenomenon known as polyembryony, which arises through the development of embryos from other cells within the ovule. This embryo is haploid and the seedling which grows from it is generally smaller than the

seedling from the fertilized ovum—a diploid cell. Mr. Lippiatt is taking special note of the cases in which two or more seedlings grow from one pip.

The sixteen seedlings showed a wide variation in general characters—foliage, thorns, and nature of growth. Some appeared better, some worse, than existing types of New Zealand citrus. All showed orange, grapefruit, or mandarin foliage in a more or less marked degree. The reason for the wide variation is explained by cross-pollination. Citrus is generally propagated vegetatively or asexually by means of buds in order to reproduce a tree true to type. In the case of planting seeds which are really the fertilized eggs or ova known as the zygote, all the heredity characteristics or genes of both male and female gametes will appear. The New Zealand grapefruit is itself a hybrid between an orange and a pomelo. What, then, could be expected from this Island grapefruit which had been cross-pollinated by the sweet oranges of the Islands. It was on this theory that Mr. Lippiatt was working, and from it he hoped to obtain a wide range of seedlings. This is what actually resulted. To say at this juncture that he hoped to obtain an improved Poorman's or an orange suitable for New Zealand conditions would be quite incorrect. He had no idea what would result. They might all have been useless. It was the system by which many great discoveries have been made—the trial and error method.

Influence of Humidity.

The grapefruit succeeds better than the orange under conditions of greater relative humidity. This is shown by the superiority of Florida grapefruit over Californian, whilst the reverse is true regarding oranges, which do better under irrigation conditions. Mr. Lippiatt's seedlings showed their grapefruit ancestry in that the fruit is borne as a cluster or spray, not as individual fruits as with oranges. They also fruited earlier than would Island orange seedlings under similar conditions.

From the sixteen seedlings fruit has now been obtained from nine. Fruit from six of these was valueless and need not be considered further, but fruit from trees numbered 1, 2, and 3 is of interest. To deal with No. 3 first: This tree is at present growing on the property of Mr. R. W. Nicholls, of Mangere, but the remarkable feature about the fruit was that it appeared identical with that of New Zealand Poorman. When Mr. Lippiatt took one fruit of No. 3 and two ordinary Poorman's oranges into Messrs. Turners and Growers, out of half a dozen people not one picked the seedling. When cut and tasted one could not distinguish it from the Poorman's except that the centre is a hollow core, not solid as in Poorman's, and the flesh is a deeper golden colour. How, then, came this fruit from a seedling tree raised from an Island grapefruit to be similar in every way to a New Zealand Poorman's? The history of the New Zealand Poorman's as outlined above shows it to have been imported from India, and inquiries regarding the imported Island grapefruit resulted in the discovery that Mr. Hewett had received his trees as a gift from an Englishman after his return to India following a visit to the Islands. The fruit from these trees is not now sold locally, as

Mr. Hewett has died and his orchard has changed ownership. This fruit resembling the New Zealand Poorman's thus confirms the theory as previously advocated by leading citriculturists that the New Zealand Poorman's is a hybrid or cross between the sweet orange and the Indian pomelo.

Seedlings numbered 1 and 2, however, are now the ones from which Mr. Lippiatt hopes to obtain a finer strain of grapefruit. The fruit obtained was a sweeter grapefruit or a stage nearer the result of a suitable New Zealand sweet orange—that is, one adapted to local conditions, equal to the imported fruit in quality and flavour and suitable to the grower in bearing good regular crops of high quality. Besides being sweeter than New Zealand Poorman's, it is also a good commercial size and thin-skinned. Unfortunately, Nos. 1 and 2 growing on their own roots have died of collar-rot, but before dying No. 1 had set a crop of approximately 260 fruit, indicating it should be a good cropper. The soil of the area is rather heavy and wet, and pomelo or its derivatives is not a rootstock resistant to unfavourable conditions. Realizing that his two best seedlings were dying, Mr. Lippiatt made a fine effort and has saved the valuable budwood of No. 1. The buds were inserted into younger seedlings. This is not a usual procedure, and in normal circumstances would be considered as senseless to put buds of a tree on to a similar rootstock, but these seedlings were all that Mr. Lippiatt had available at the time.

The seedlings were raised from the seed of five cases of similar fruit from a consignment from Aitutaki four years later. These seedlings were sown in a small nursery area at the rear of the house, and, owing to unfortunate circumstances, were neglected for a year or two. Some of the seedlings were given to a nurseryman, who used them as stocks and thus are lost to the industry, others have been given away, but a considerable number remain on the property. The No. 1 budwood has been put on these and the stock or secondary seedling root has been allowed to remain in order to see if any other good-quality fruit result. One remarkable feature, however, of the No. 1 bud is that in all cases it has developed, even after being dormant for a year. It becomes a vigorous shoot and forms naturally a fine tree without any necessary forming by the nurseryman. The No. 1 trees show remarkable vigour, fine foliage, and the black-streaked bark so characteristic of the New Zealand Poorman's. No. 1 was growing on Mr. Lippiatt's property. No. 2 grew at Mr. Graham's across the road. It died as a result of the storm of February, 1936, but fruit borne was practically identical with that of No. 1.

Already the news has spread of this promising seedling, and although one is quite unable to secure any sample fruits until the No. 1 buds again reach fruiting-age, yet several nurserymen are working up the variety on different stocks, so that in a few years the capabilities of this seedling will be seen under varying conditions. Growers are already making inquiries, but another two years will probably elapse before the seedling is released for sale.

In the meantime Mr. Lippiatt has indicated the manner in which progress and research can be made towards finding the ideal New Zealand sweet orange, and to him the citrus industry is indebted for his interest and zeal over the past ten years.

HALF-YEARLY FERTILIZER RETURNS.

THE following returns have been compiled by the Inspector of Fertilizers, Fields Division, Department of Agriculture, from figures supplied by the courtesy of the Comptroller of Customs:—

(Figures in Tons.)

Fertilizer.	Origin.	Jan.	Feb.	Mar.	First Quarter.	April.	May.	June.	Second Quarter.	Half-yearly Return.
					Phosphates.					
Rock ..	Gilbert and Ellice Islands	15,380	4,129	14,310	33,819	2,581	11,503	1,003	15,087	48,906
	Nauru ..	9,017	6,186	..	15,203	15,854	11,383	38,446	65,683	80,886
Total ..	..	..	..	..	..	..	..	..	..	129,792
Slag ..	United Kingdom	155	1,050	15,703	16,908	12,638	1,729	401	14,768	31,676
	Belgium ..	225	10,435	12,303	22,963	8,260	9,115	250	17,625	40,588
Total ..	..	..	..	..	..	..	..	..	..	72,264
Guano ..	United Kingdom	..	..	..	..	..	..	5	5	5
	Seychelles ..	..	10,379	..	10,379	..	..	2,980	2,980	13,359
Total ..	..	..	..	..	..	..	..	..	..	13,364
Other phosphatic manures	Egypt ..	..	..	..	..	..	..	2,700	2,700	2,700
	Belgium ..	..	400	3,285	3,685	1,135	3,672	625	5,432	9,117
Total ..	..	..	..	..	..	..	..	..	..	11,817
Total, phosphates ..		..	..	..	..	..	..	..	..	227,237
					Potash.					
Kainit ..	Belgium ..	..	..	25	25	..	..	..	..	25
	U.S.A. ..	..	25	..	25	50	..	20	70	95
	Germany ..	..	105	..	105	20	205	..	225	330
	France ..	20	20	..	40	..	..	25	25	65
Total ..	..	..	..	..	..	..	..	..	..	515
Sulphate ..	France ..	25	..	5	30	85	105	25	215	245
	Germany ..	10	75	5	90	126	49	161	336	426
Total ..	..	..	..	..	..	..	..	..	..	671
Muriate ..	France ..	..	..	..	..	55	..	35	90	90
	Germany ..	4	..	..	4	22	1	..	23	27
Total ..	..	..	..	..	..	..	..	..	..	117
Other ..	France ..	100	780	1,400	2,280	435	525	450	1,410	3,690
	Belgium ..	..	5	30	35	..	..	..	..	35
	Germany ..	35	1,437	678	2,150	460	922	735	2,117	4,267
Total ..	..	..	..	..	..	..	..	..	..	7,992
Total, potash ..		..	..	..	..	..	..	..	..	9,295
					Nitrogen.					
Sulphate of ammonia	United Kingdom	135	440	..	575	800	278	450	1,528	2,103
Nitrate of soda	United Kingdom	175	..	..	175	..	..	..	..	175
	Chile ..	..	469	..	469	115	314	75	504	973
	Netherlands ..	1	..	..	1	..	..	..	..	1
	U.S.A. ..	..	..	400	400	..	50	75	125	525
Total, nitrogen ..		..	..	..	..	..	..	..	..	3,777
					Miscellaneous.					
Miscellaneous	Australia ..	..	..	10	10	..	..	..	..	10
	United Kingdom	1	20	13	34	54	42	4	100	134
	India ..	..	..	..	..	..	..	2	2	2
Total, Miscellaneous ..		..	..	..	..	..	..	..	..	146
Totals ..	..	25,283	35,955	48,167	109,405	42,690	39,893	48,467	131,050	240,455

MOLE DRAINAGE IN THE MANAWATU.

By C. J. Hamblyn, Fields Superintendent, Palmerston North, and A. J. Galpin, Fields Instructor, Palmerston North.

For many years the mole-drain plough has been used in the Rangitikei, Manawatu, and Woodville districts of the Wellington Province in an endeavour to improve cheaply and effectively the drainage on extensive areas of the heavy loam soils which overlie stiff impervious clay subsoils. The bulk of the country on which mole drainage has been practised consists of rolling and flat-topped low hill country bordering the river flats and river terrace land. Much of this country is dissected by narrow valleys and deep depressions, while in other areas the land gently slopes away from the general level to wide open valleys. The majority of the land is ploughable. The soils are fertile, but there is a definite tendency to rapid reversion of pastures to dominant brown-top, due to the excessively wet condition of the surface soil in winter. Rushes are a serious problem, foot-rot is bad in sheep, pastures are frequently badly poached by cattle in wet winters, and the spring growth is backward.

Mole drainage has often given disappointing results from the point of view of lasting improvement, and many well-established farmers have resorted eventually to the much slower, infinitely more expensive, but more lasting method of tile drainage.

Twelve years of practical experience with the mole-drain plough on his property at Colyton in the Manawatu has resulted in the development by Mr. Bruce McLeod of a method of mole drainage which is thorough, very efficient, relatively cheap as compared with tile drainage, and, what is still more important, promises to be lasting.

The guiding principles in Mr. McLeod's method, though simple, are yet of extreme importance in successful and lasting mole drainage. First, the provision of permanent outlets; second, the provision of a definite and uninterrupted fall from the highest point of each mole drain to the outlet; and third, provision of a sufficient force of water especially near the outlets to clear the system of silt at the commencement of the rainy season. Though the actual mole drain will last for many years when drawn in a suitable clay subsoil, it is the gradual accumulation of fine silt which eventually blocks the drains and renders them useless. During dry summers the soil dries out down to the mole drains and the sides tend to flake. At the beginning of the rainy season there is a deposit of silt in the mole drains. This silt cannot be cleared from the system if the outlets are blocked, nor can it be cleared if there is little or no fall. The special tendency to silt up in depressions is the reason for maintaining a steady but definite fall throughout the course of each drain.

Mole drainage of the 300 acres of Mr. McLeod's homestead portion of his farm has recently been completed with the new system. The first paddock was dealt with five years ago. It is believed that the methods adopted will prove of interest and value to farmers in various parts of New Zealand where similar conditions occur, and for this reason are here described and illustrated.

The chief feature of Mr. McLeod's system is the elimination of the usual large number of individual mole-drain outlets which are so liable to blockage. This is done by using one in every four to eight mole drains as an outlet for the group, and, further, the gathering of as many of these outlet drains to discharge at a suitable selected place where a permanent tiled outlet can be put in. In this way the drainage from forty to fifty or more individual mole drains can be collected to discharge at one point, and the number of outlets required for the complete mole drainage of a large area reduced to a minimum. The provision of material such as tiles for permanent outlets is then not costly.

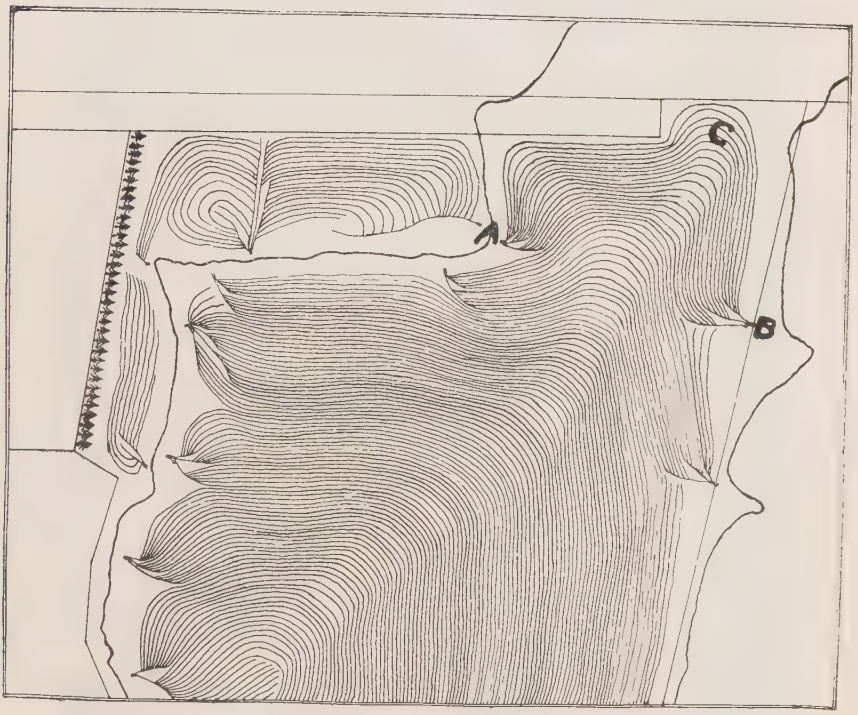


FIG. 1. PORTION OF A COMPLETED SCHEME OF MOLE DRAINAGE ON A 32-ACRE PADDOCK, SHOWING OUTLETS A AND B AND RIDGE C REFERRED TO IN TEXT.

Layout of Drainage Scheme.

A study is made of the paddock or area to be mole-drained, particularly when heavy rain has fallen, and in addition to the selection of suitable locations for outlets, the run and line of the mole drains is roughly schemed out. For this purpose a dumpy level is invaluable. The eye is often deceived regarding the direction of fall.

The number and location of outlets is worked out in relation to the general lie of the country. The possibility of gathering together near the outlets as many mole drains as possible so as to reduce to a minimum the number of main outlets required is the chief guide in selecting these outlets.

As a general principle mole drains are most effective when they run across the steepest slope, but a steady and definite fall must be maintained from the highest point to the outlet with a more decided fall if possible just before the point of discharge. The drainage of such country as at Colyton, gently rolling for the most

FIG. 2. THE MOLE PLOUGH SET UP IN THE OUTLET READY TO BE DRAWN ACROSS THE BLIND ENDS OF INTERMEDIATE MOLE DRAINS ALREADY DRAWN.

part, with steep slopes to watercourses round the edge of the paddocks, lends itself admirably to the methods developed, but it is surprising how the same system of collecting mole drains for discharge at selected outlets can be adapted to varying conditions on different types of country. It is occasionally necessary to alter the line of fences to give access to suitable outlet locations.

Fig. 1 illustrates portion of a completed scheme of mole drainage on a 32-acre paddock, and shows the location of fences and of the outlets which discharge down the banks bordering the watercourses. The outlets consist of short trenches dug back from the point of discharge whatever distance is required to give easy access for the mole plough.

Drawing the Moles.

Having fixed the site of two outlets such as A and B in Fig. 1, the mole plough is set up near outlet A and following round the contours and over the ridge at C the plough is tripped and leaves the ground near outlet B. The tractor turns, the plough is set up again near outlet B, and a parallel mole drain is drawn 6 ft. to 9 ft. or up to 11 ft. from the first drain. The plough is next tripped at

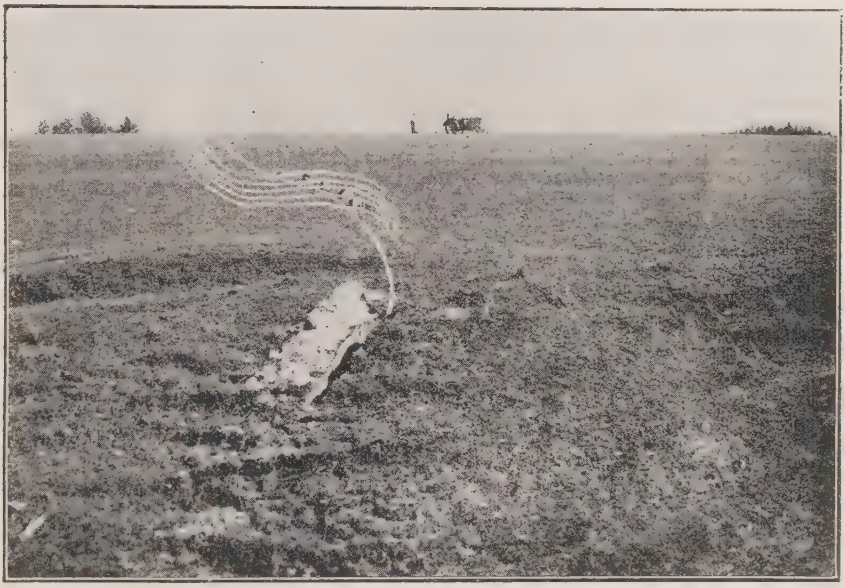


FIG. 3. AN OUTLET DRAIN SHOWN CUTTING ACROSS THE ENDS OF FOUR INTERMEDIATE DRAINS AND CONTINUED ON AS AN ORDINARY MOLE DRAIN.

outlet A, and the process repeated until four to six mole drains are drawn. The plough is next set up in the outlet drain A, Fig. 2, and without altering the depth is drawn so as to cut across the blind ends of the drains already drawn. This drain is continued on as an ordinary mole drain to outlet B. The plough is then set up in outlet B, and again the plough is drawn so as to cut across the previously made mole drains. The process is illustrated in Fig. 3. The method of cutting across the ends of groups or fans of completed drains with gathering drains opening into the outlets is continued across the field. New outlets are made use of as the work proceeds. Where it is not possible to work to two outlets the mole is drawn to the highest point required away from the outlet, the tractor turned, and a parallel drain drawn back to the outlet.

FIG. 4. ILLUSTRATES THE HOLE DUG IN THE BLIND END OF THE INTERMEDIATE DRAINS AND THE CLEARANCE OF THE CLAY PLUGS WITH THE CORKSCREW IMPLEMENT.

FIG. 5. A SERIES OF OUTLET MOLE DRAINS DISCHARGING INTO THE OUTLET TRENCH.

Each of these outlet mole drains is connected with 4 in. to 6 in. or more intermediates.

The same method of cutting across the ends of groups of these drains with a mole drain discharging direct into the outlet is adopted. It will be noted that the mole plough is in the ground the whole of the time with the exception of the short turns, and that no time is wasted running back to the outlets empty.

Linking up Outlet Drains with Intermediate Mole Drains.

Each of the intermediate drains terminates in a blind end, and while the tractor work is going on the work of connecting these intermediates up with the outlet mole drains leading to the outlet ditches is proceeded with. The crossing of these intermediates with a mole drain intended as an outlet results in the complete blocking

FIG. 6. IMPLEMENT USED FOR MAKING HOLES IN TILES AND CUTTING TILES TO LENGTH REQUIRED.

of the first drawn drains, whether the outlet drain is drawn at the same level as in this case, or within 2 in. or 3 in. either above or below. For the purpose of providing for the free passage of water, and, what is more important, for the clearance of silt in later years from the intermediates to the outlet drain, a clean, full-sized connection must be made between them. This is easily and rapidly accomplished with the aid of a simple tool, made in the form of a corkscrew, with a universal joint in the handle.

The points where the outlet drain cuts each intermediate are marked; a hole is dug in the blind end of the intermediate down to the mole drain so as to cut it at a short distance from its junction with the outlet drain. The special corkscrew augur with a universal joint is then used, as illustrated in Fig. 4, to clear

the clay plugs blocking this drain. With the removal of these plugs, if there is sufficient water in the mole drain, it will run into the hole which was dug, but can be diverted to the outlet

FIG. 7. FOUR-INCH TILES FITTED IN THE OUTLET AND CONNECTIONS WITH THE OUTLET DRAINS.

Note packing of clay round tiles and over the outlets.

drain by plugging up with good clay the open end of the mole drain which has just been cleared. The hole is then filled in and the connection is completed.

The Permanent Outlets.

The final process is the laying of tiles, preferably 4 in. unglazed drain tiles, in each of the outlet ditches to give a permanent

outlet not likely to be trampled in and blocked by cattle or sheep. The bottom of the outlet trench into which the outlet mole drains have been drawn, as shown in Fig. 5, is built up so that the tiles when laid will be close up to these openings. Holes are made with the implement shown in Fig. 6 in the sides of the tiles opposite the mole drain outlets, and pieces of tile or special short lengths of 2½ in. tile are used to make a direct connection between the moles and the tile drain. Sticky clay is then used to pack over the connections and along the length of 4 in. tiles to ensure a permanent job (Fig. 7). The outlet is then filled in. The implement used for cutting tiles to suitable lengths and for cutting

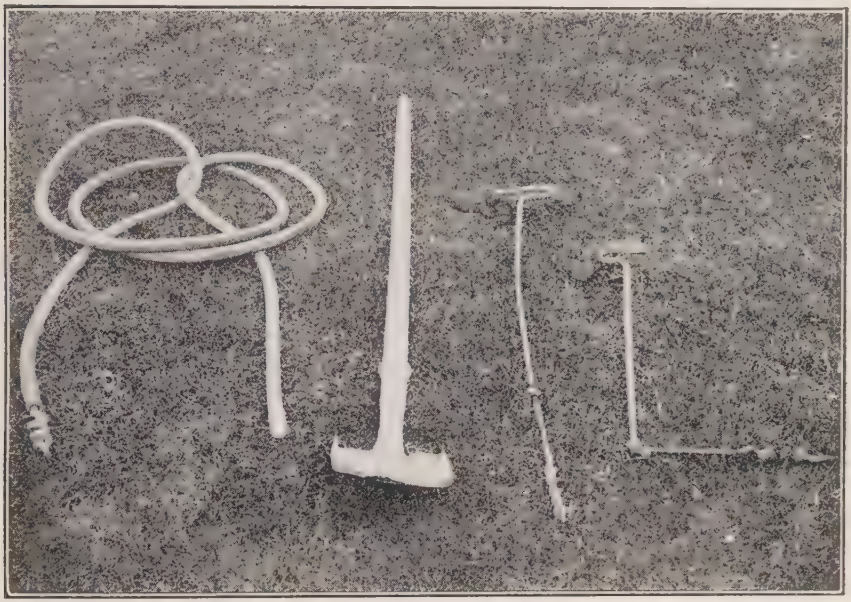


FIG. 8. SOME OF THE OTHER TOOLS USED AND DESCRIBED IN THE TEXT.

holes in the sides of the tiles is made from an ordinary worn mower-knife section fitted to a short handle. The hammer is used to punch out the hole when the outline is sufficiently chipped with the other implement.

The length of ¾ in. hose fitted with a corkscrew at one end and a plug of hardwood at the other is useful for clearing obstructions in the outlet drains when, as sometimes occurs, the plugs are not properly cleared from the intermediates. It is also useful later in clearing obstructions such as silt accumulations near the outlets and in maintaining the drains in good order (Fig. 8).

Efficiency of this Method of Mole Drainage.

The effectiveness of mole drainage is illustrated in Figs. 9 and 10. Fig. 9 shows the surface of a paddock as yet undrained,

the pasture weak and open, the soil wet and sloppy—ideal conditions for sheep parasites and bad foot-rot, and always liable to rush invasion. Fig. 10 illustrates the conditions on an adjoining field mole-drained for four years and sown to the same good rye-grass and white clover. The rye-grass and clover are flourishing, with little chance of reversion to brown-top or rushes. The surface is dry and firm and able to carry heavy cattle during the winter.

FIG. 9. TYPICAL WINTER CONDITIONS OF UNDRAINED LAND AT COLYTON.

Permanence and Renewal.

Most of the usual methods of mole drainage on such country had been tried out during some twelve years by Mr. McLeod, including the connection of deeper outlet drains with intermediates by means of a spear or the use of totara slabs placed over the junction when this had been cleared. His experience has been that generally the efficiency of the drainage has improved up to about three years, then there has been a rapid falling-off in the effectiveness. Wet patches appear and spread throughout the field, until the system has to be renewed in about five years. Although the first area drained by the new method has been done for five years only, the fact that there has been a steady improvement in the effectiveness of the drains during this period and that the discharge of water at the outlets after rains is still as good as ever indicates that a much more permanent and satisfactory job has been done. Renewal of the drainage system if and when required is not difficult in that to commence operations all that is required is to dig out the short length of tiles from each outlet.

Costs.

Detailed costs for the complete mole drainage of the 32-acre area from which the illustrations in this article were obtained are as follows:—

	£	s.	d.
Fuel, 42 gallons at 1s. 1d.	2	5	6
Oil, 29 hours at 3d. per hour	0	7	3
Wages, 3 men, 29 hours, at 2s. per hour ..	8	14	0
Depreciation tractor and plant at 1s. 6d. per hour	2	3	6
Tiles for outlets	0	18	0
Wages, 2 men, 8 hours, at 2s. per hour (tiling outlets)	1	12	0
Total	£16	0	3

Cost per acre, 10s.

Scope of Mole Drainage.

The essential conditions for satisfactory mole drainage are—

(1) A suitable stiff clay subsoil free from obstructions such as ironstone pans, roots, or large stones, which would interfere with the drawing of the mole-drain plough through the soil.

(2) The stiff impervious subsoil must be within 20 in. to 22 in. of the surface, as this is the maximum depth that the usual plough will go.

(3) There must be an appreciable fall in the direction of the mole if the drains are to last.

On flat land or land with little fall mole drains do not last, but are often well worth putting in because of their effectiveness while they last.

There are many thousands of acres of country in the Manawatu, Rangitikei, and southern Hawke's Bay Districts with conditions almost ideal for effective and lasting mole drainage. Fig. 10 is a typical illustration of such country. The free drainage of several inches of dark loam soil is held up by a stiff impervious clay subsoil, the fall is generally good, and suitable places for outlets are easily found. The lower ploughable slopes of much of the steeper hill country in many districts lie wet and cold in the winter because of the stiff subsoils, and the mole plough can be used with good results on such land. In many other districts, particularly in North Auckland and Southland, the stiff clay soils can often be drained and improved by mole drainage and the method described above adopted with advantage.

The mole plough is not effective on relatively loose and open soils where the drainage may be bad on account of a pan formation. Mole drainage, though effective, cannot be made lasting on relatively flat land, such as river flats and swamp land, even where the subsoil may be ideal for the purpose. The fall is not enough to keep the drains cleared of silt, and they rapidly tend to silt up, although the outlets may be kept clear.

FIG. 10. EFFECT OF MOLE DRAINAGE—CONDITIONS GOOD FOR THRIVING PERENNIAL RYE-GRASS AND WHITE CLOVER.

FIG. 11. PORTION OF MR. MCLEOD'S FARM AFTER EFFICIENT MOLE DRAINAGE SHOWING ABSENCE OF RUSHES AND DENSE SWARD OF RYE AND CLOVER.

If mole drains will last, however, for three to four years, as they often do in land with a slight fall, and can be put in for a few shillings per acre, the effective removal of surface water is well worth while. The renewal of the drains is easily done when a tractor and mole plough working to suitable open drains can do up to 15 to 20 acres per day.

Opinions vary as to the best depth to draw the moles and the best time to do the work, but the following general recommendations are considered sound under average conditions.

Depth of Drains.

A minimum depth of 12 in. with the plug working at least 2 in. in the clay subsoil is advisable. With mole drains nearer the surface the sides of the drain are likely to crumble rapidly in dry weather. There is also the danger of damage to the drains at soft spots by heavy cattle or by the plough. Mole drains drawn deep in the clay, particularly in stiff impervious clays, are generally ineffective, the water taking too long to pass into the drains. Deep drains, however, last well. In practice, a depth of 14 in. to 18 in., with the mole drains about 3 in. in the subsoil, is found to give good results in rapidity of drainage and in lasting drainage.

Time to drain.

The best time to do the work is when the subsoil is wet and the surface dry. The dry surface means less cutting about and more effective pulling-power of the tractor. The wet subsoil ensures less draught and good clean mole drains. Suitable conditions seldom occur both in respect of the dry surface soil and wet subsoil until the land is drying out in the spring. September and October are often good months in which to do the work. Mole drains drawn under very wet surface conditions are liable to blockage by soil going down the knife cuts. The results, however, are quick and spectacular, and there is a tendency therefore to do the work under these conditions which are not at all favourable for lasting work.

There are a number of other points regarding mole drainage—the size of plug, speed of the plough, pulling across the steepest slope, not crossing depressions, correct spacing, and many others which should be considered. A $2\frac{1}{2}$ in. to 3 in. plug is generally used, and this size of plug is suitable to most conditions. The stiffer and stickier the soil the smaller the plug, and *vice versa*.

The best speed for the plough is about two miles and a half to three miles per hour. Fast work is not desirable, as the drain-sides tend to be drawn in, and in somewhat dry soils will flake.

Although it is held that the mole drain lasts better if drawn away from the outlet and up the slope, this is not essential to good work. Permanent outlets and the provision of sufficient pressure in the stream of water down the moles is considered of far greater importance, and also the saving of time when the plough is kept in the ground continually.

Depressions should not be crossed, as silt is liable to collect in the depressions in the drains and cause blockages. The modern type

of light mole plough can be used to cross narrow finishes and fearings, as the general depth of the mole drain is not affected in crossing these (Fig. 11). An effective spacing in most soils is about 9 ft., but on very wet, stiff soils the moles should be as close as 6 ft. Mole drains should be close together when running down the grade and wider apart across the fall or steeper slopes.

FIG. 12. THE LIGHT, EASILY ADJUSTED TYPE OF MOLE PLOUGH FAVOURED IN THE MANAWATU DISTRICT.

Conclusion.

The method of mole drainage described in this article is confidently recommended to those practising mole drainage under similar conditions, and farmers are further recommended to consider the possibilities of the mole plough where good drainage is required.

The writers wish to record their thanks to Mr. McLeod for making available the practical details of his methods, and also to the official photographer, Mr. Harvey Drake, who is responsible for the illustrations.

The importance of surface-sowing subterranean clover at the most suitable time has been well shown in the Manawatu district in the past season. Areas sown in early February appear much further ahead, both in number of plants germinating and also in their vigorous growth, than areas sown later in the autumn. This year, owing to the high summer rainfall, subterranean clover could be sown much earlier than usual with good results, and those that took the opportunity appear to have been well repaid.

SEASONAL NOTES.

THE FARM.

A Cause of Poor Results from Top-dressing in Lamb-production.

RECENT official statistics show that last year's record number of breeding-ewes in the Dominion has been exceeded this year. This new record number of breeding-ewes probably is, and certainly might fittingly be, connected with the evidence from sales of fertilizers that increased top-dressing of grassland has been carried out in the sheep-farming of at least several districts; there is much farm experience indicating that judicious top-dressing of suitable pastures can be made a direct and profitable means of producing greater numbers of better lambs. Such experience continues to become available in increasing volume not only from districts of more than 30 in. of annual rainfall, but also from ones of considerably less rainfall.

While the general position is that top-dressing has been found of value in producing a bigger and more profitable crop of lambs, it is desirable to bear in mind, especially at this season of the year, that farmers are to be found in both the North Island and the South Island who, on the basis of personal experience, state unhesitatingly that top-dressing has been associated with poor results in the production of lambs. Close scrutiny of their experience often has certainly confirmed their statements, but at the same time has provided an explanation of the poor results. It is of great practical importance that this explanation has in no respect affected the general validity of the fact that over wide areas top-dressing may be employed to increase the output and the net returns in lamb-production.

In short, top-dressing has been linked with exceptionally good results and quite poor results in lamb-production, and this in the one district under similar conditions of soil climate and original pasture-covering and with the same type of top-dressing material used when the results were both good and bad. This somewhat paradoxical position arises primarily from the fact that using fertilizer on grassland and using the results from fertilizer on grassland are two totally different matters; or, expressed in other words, it is of great practical importance to distinguish between applying fertilizer and using fertilizer on grassland having in mind that, according to the dictionary, "use" means "application to a purpose." In farming, and especially in sheep-farming at times, the application of fertilizers to pastures has been judicious, while later on the use of the results of the fertilizers has not been judicious.

The crux of the position is given pithily in the following statement of Dr. Fraser of Rowett Institute:—

"Ewes and lambs will never thrive on stemmy pastures . . . I have repeatedly noticed how lambs go off when grass shoots and clover flowers."

This statement introduces no new idea: it merely emphasizes a fact that is demonstrated throughout a countryside whenever that countryside enjoys weather that favours unusually rapid growth of pastures in spring and early summer and the sheep-farmers do not take adequate measures to cope with the surplus feed that results. Judicious top-dressing begets additional feed just as favourable weather conditions may beget additional feed: either top-dressing or favourable spring and early summer weather may lead to poor results with lambs unless the surplus feed is handled in such a way that stemmy pastures for the ewes and lambs are avoided.

Phosphatic top-dressing when it is effective, as it so commonly is, intensifies the superabundance of feed directly available from grassland in

the late spring and early summer. Hence if top-dressing is not followed by measures for dealing with an increased supply of feed at this period, then usually and almost necessarily a stemmy condition of the pastures develops about November, and, stemmy pastures being eminently unsuitable for ewes and lambs, sheep that were thriving up to the appearance of stemminess in the feed soon cease to thrive.

From this it follows that as a rule the man who condemns top-dressing as a factor in profitable lamb-production has to face one of the following alternatives: Either his top-dressing has not been suitable to his conditions and has not produced enough additional feed to become profitable or the top-dressing has been effective enough and there has been failure in some other phase of the management of the farm so that the additional feed has not been used properly. In either case the poor result originates in poor management.

A Parallel Position in Dairying.

When the weather in spring and early summer has favoured rapid growth of pasture not infrequently the production of herds begins to fall in November or early December at a rate which is greater than is natural in satisfactory dairy stock being fed efficiently. Such an abnormal falling-off in production is almost always if not always, associated with the development of stemminess in the pastures. Stemmy pastures intrinsically are unsuitable for the feeding of cows of reasonably good productive capacity because heavy production is possible only in animals receiving a liberal supply of feed of high digestibility and the digestibility of the feed from pastures is greatly impaired as their stemminess due to an increased content of fibre increases. About 80 per cent. of the dry matter of leafy pasture-growth is digestible, whereas only from 40 per cent. to 60 per cent. of the dry matter of stemmy growth is digestible. Hence a given weight of the dry matter of stemmy growth may be only half as nutritious as the same weight of the dry matter of leafy growth and readily may provide inadequate nutriment for dairy cows over and above that required for mere maintenance to enable full productive capacity to be exercised.

Especially may poor results be expected in the case of pigs supporting themselves mainly on stemmy pastures; actually some of the poor results recorded from summer grazing of pigs may be attributed definitely to the stemminess of the pasture to which they had access. The ready way in which pigs react unfavourably to stemminess in pastures is due primarily to the fact that pigs are less fitted naturally to utilize feeds of low digestibility than are cattle and sheep—in the pig the volume of alimentary canal, in which digestion takes place, per 100 lb. of live-weight is much less than in cattle and sheep. Largely because of the comparatively restricted capacity of its alimentary canal or food tract the pig cannot utilize economically feeds of high fibre content; in this connection it is instructive to contrast coarse pasture growth having 20 per cent. of fibre in its dry matter with skim-milk from which fibre is absent and leafy pasture growth having approximately 10 per cent. of fibre in its dry matter.

Importance of Summer Control of Pastures.

The above considerations point unquestionably to a past common weakness in the management of pastures due to the fact that but little attention has been paid to the influence of the mechanical character of feed on the response of the animal when in feeding; this is actually of primary moment. A fact which obtrudes itself in practice is that in assessing the nutritive value of feeds for live-stock attention must be given not only to such matters as chemical constitution, vitamins, and minerals, but also to the physical or mechanical constitution of the feed. The extent to which the latter has been overlooked in our grass-farming has been very detrimental to returns; every pasture in which flowering stalks are prominent in

summer is an instance in which the feed has deteriorated from the mechanical aspect of nutrition—its fibre content has increased and its digestibility has decreased correspondingly.

How to avoid stemmy pasture is a question which must be dealt with during the next few weeks. In dairying the measures that widely have proved decidedly valuable to this end are (1) suitable systematic grazing management; (2) adequate saving of silage and hay; and (3) topping of pastures with the mower.

Suitable systematic grazing is not at all difficult to carry out as may be gleaned from the fact that the essential steps in quite effective grazing on many farms have been :—

(1) Rapid grazing of fields by relatively heavy stocking. Stocking at the rate of from six cows an acre upwards for periods of from one to three days has in practice given excellent results. The tendency definitely is for the best results to come from periods of only one day's grazing, which necessarily call for greater frequency in grazing than is advisable when the grazing-periods are of longer duration.

(2) Subsequent complete spelling of the pastures to allow of recovery sufficient to give the amount of grazing already specified. According to the rapidity of the pasture-growth spells of from about seven to fourteen days' duration have given good results.

Really close grazing of the pastures is at no stage necessary; in fact, it is undesirable. Hence suitable systematic grazing does not call for punishing treatment of either the pastures or the stock. Splendid results are being obtained on many farms on which nine to twelve paddocks are under grazing.

A most important aid to good results in systematic grazing is the immediate elimination, as far as is possible safely, from the grazing programme of all grassland additional to that needed to meet the current feed requirements of the stock. Frequently poor results originate in failure to attend to this. The rational course is to save the feed from the fields dropped out of the grazing programme as silage or hay. A steady improvement in the Dominion in this matter is indicated by official returns which show that 536,000 acres were used for hay and silage in 1935–36, in comparison with 251,000 acres in 1927–28. A puzzling feature of the position is the decline in the ensilage acreage from a peak figure of 116,000 acres in 1932–33 to 83,000 acres in 1935–36. As a pasture-management measure ensilage is of outstanding value because it enables the disadvantages attaching to haymaking on account of unfavourable weather to be eliminated altogether. It is of prime importance to mow fields for hay or silage during the short period in which they are at the best stage of development having regard to the future production of the pasture and the feeding-value of the hay or silage. In ensilage, the farmer is independent of the weather; hence he may mow at exactly the best stage knowing that he can save the crop in good condition irrespective of the subsequent weather and that because of suitably early mowing he later will be rewarded with leafy aftermath which is likely to be especially valuable at just the stage when it becomes available and which almost certainly would not be produced at the time it is most needed following mowing delayed until the weather is good for haymaking. In short, efficiency in the matter under consideration depends basically upon the job being done at the right stage: ensilage enables the crop to be saved at the right stage without suffering otherwise in quality.

It being difficult to gauge exactly the area of grass needed to meet the feed requirements of the stock often some surplus feed arises in early summer on the paddocks not closed for hay or silage. Usually there is not enough of this feed to enable it to be conserved satisfactorily, but

enough of it, if it is not dealt with, to spoil the control of the pasture-growth. When this is so it is as a rule advisable to check the development of coarse stemmy parts in a field by "topping" of the pastures—*i.e.*, by mowing to remove flower-heads. In this the mower should be set high. Close-mowing if followed by droughty conditions may lead to drying of the pasture and so have a decidedly undesirable result; in addition, it wastes feed. Frequently topping is deferred until it is so late that it is possible to obtain only little, if any, benefit from it. The primary objective in topping is the removal of flower-stalks and coarse growth, and the sooner these are removed after their development the better is the result.

Up to the present the three practices just discussed—systematic grazing, ensilage, and topping—have been employed with success most commonly on dairy-farms. Some farmers, however, have employed them with outstanding success on sheep-farms, and thereby demonstrated that on many sheep-farms, though certainly not on all, more could be done, and this with attractive profit, than is being done to secure such control of the growth of pastures during the early summer as would result in less stemmy and more digestible feed for ewes and lambs.

The Mangel.

Judging from advice to hand regarding sales of seed last year, there was an appreciable decline in the Dominion acreage of mangels. In some instances farmers may have been justified in reducing the area devoted to mangels or even in dropping the crop from their programme of feed provision, but in general an increase instead of a decrease in the Dominion acreage of mangels would be distinctly profitable. While exact comparisons between feeds so different in character cannot be carried very far with safety it is interesting to note that on the basis of their nutritive value mangels are worth about £1 a ton when compared with pollard at the present price in the North Island. Yields of 60 tons and over of mangels an acre are quite frequently obtained. The mangel is especially reliable, because it is subject to no serious disease or pest, and because when it receives reasonably good treatment it is able to stand a dry period comparatively well. The variety Prizewinner Yellow Globe is more widely grown than any other, this being the result largely of the consistently good yields of this variety which have been recorded over a long period. Other varieties of known good value are Red Intermediate, White Sugar, and Jersey Queen. The standard practice continues to be to sow about 6 lb. of seed an acre in rows 26 in. to 28 in. apart. There is a limited amount of field evidence which points to the practicability of obtaining greater yields by sowing in rows closer together (*e.g.*, 20 in. to 22 in. apart) and using heavier seedings (*e.g.*, 8 lb. an acre), but the amount of this type of evidence available, while suggestive, is not conclusive. Cold, wet conditions tend to cause loss or stunting of seedlings, and therefore sowing should not be done before warm conditions in the soil may be expected; over wide areas sowing before November is not advisable.

The mangel responds profitably to preparatory cultivation, which brings about a fine, firm seed-bed, and the best and cheapest way of obtaining such a seed-bed is to begin the job well ahead of seed-sowing.

The manurial needs of the mangel vary with soil and climatic conditions, but field results have shown that as a rule good returns may be expected from the use of a dressing of 5 cwt. to 6 cwt. an acre of a mixture consisting of equal parts of superphosphate and blood and bone or three parts of superphosphate to two parts of blood and bone. In districts in which benefit has been obtained from the use of potassic fertilizers the use of 2 cwt. to 3 cwt. of kainit an acre is likely to prove profitable.

Good treatment for the mangel in respect to both cultivation and fertility is specially advisable, and if the probability of giving the crop good treatment seems small, then another less exacting crop such as swedes or chou

moellier should be grown. But the mangel responds so strikingly and profitably to good treatment that it should be grown much more widely whenever it is possible to meet its needs. Because of the really heavy yields of which it is capable it is especially suitable on costly land—it enables the heavy fixed charge of rent or interest on the land to be more widely spread.

Causes of Inefficient Ensilage.

Unfortunately, a good deal of inefficiency characterizes ensilage in New Zealand. In addition to failure to utilize up-to-date labour-saving equipment and means of storage—*e.g.*, trenches and pits—among the main causes of inefficient ensilage are :—

(1) Too late mowing of the crop, which, as a rule, leads to a falling-off in quality that substantially outweighs any increase in quantity. The material resulting from too late mowing is unduly stemmy or woody, and this, irrespective of the curing process, is associated with the poor balance in the supply of nutriment and the low digestibility that characterizes any over-mature pasture-growth.

(2) Curing at excessively high temperatures, which results in avoidable loss in feeding-value. This often may be remedied by more speedy ensilage. Partial wilting of the material tends to lead to high temperatures, but in dealing with very sappy material partial wilting may be advisable. As a rule, additional green material should be placed upon that already gathered as soon as the latter begins to sink in height because of the curing process. If this rule is followed temperatures in the vicinity of 100° F. will develop and silage of a greenish to a yellowish tint usually will result.

(3) Insufficient exclusion of air, which leads both to too high temperatures, resulting in silage which is too dark and in wastage due to decay. This fault may be removed or lessened by more thorough packing in the pit or trench and by more adequate covering of earth or other sealing-matter, which, to minimize wastage, should usually be placed in position practically as soon as all the green material has been gathered. It is more difficult to exclude air sufficiently from stemmy than from leafy green material, and because of this late mowing tends to less efficient curing and more wastage.

—R. P. Connell, Land Utilization Officer.

THE ORCHARD.

Pest and Disease Control.

THE effective control of pests and diseases in the orchard will be the chief concern of orchardists for the next month or so, and it will be necessary to be on the watch for the first appearance of disease, so that early and appropriate measures may be taken. Showery weather, with warm spells intervening, is usually experienced at this period of the year, making it more difficult for the orchardist to apply the respective sprays at the proper times. It should also be remembered that such weather is favourable for the spread of fungous diseases, and at the same time insect pests will also be on the increase. Of the fungous diseases, black-spot is probably the chief consideration in most orchards. Growers should anticipate an attack rather than wait until the disease makes its appearance on foliage and/or fruit—to obtain success the treatment must be preventative and not curative.

The advice given in the last month's notes in the *Journal* should be carried out as far as climatic conditions will permit. Should rain follow before the spray has had a chance to dry on the trees it will be necessary to repeat the operation as soon as possible to replace the protective film of spray. From now on growers will be using specifics in combination when applying sprays, and care must be exercised to avoid damage being done to either

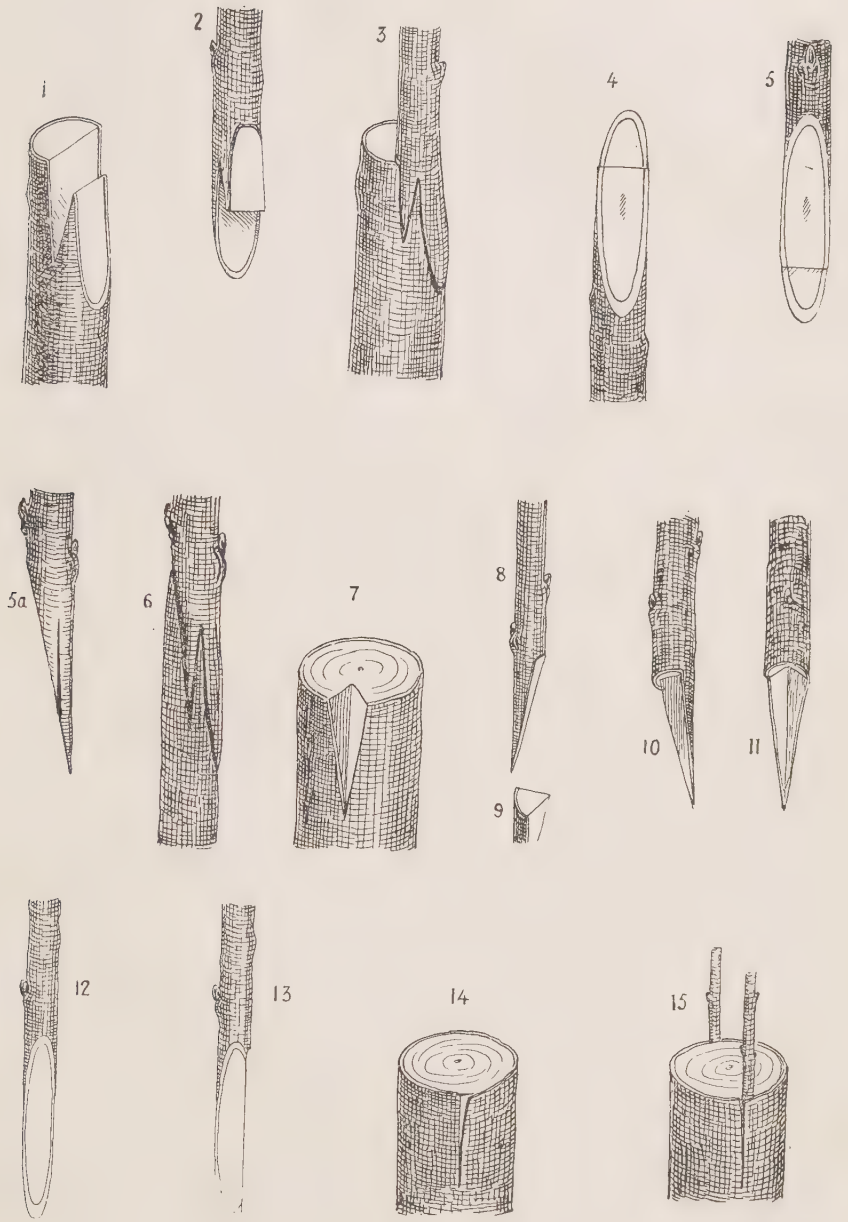
foliage or fruit. While the application of sprays usually costs more than the materials used, and the combining of two or more sprays is an advantage, three factors should be kept in view—(1) disease-control, (2) injury to tree, and (3) russeting of the fruit. On some of the tender-skinned varieties the use of colloidal-sulphur in place of lime-sulphur is recommended after the "petal-fall" period, but growers will have to be guided in their choice of these specifics by weather-conditions ruling at the time. Tests carried out with lime-sulphur at strength, 1 per cent. polysulphide content (1/150), plus colloidal-sulphur at 2 lb. per 100 gallons of spray, have proved very effective for the control of black-spot; in fact, in many cases the results have been better than where lime-sulphur was used alone, and the risk of russeting the fruit has been minimized. There appears to be very little advantage in using a spreader in sprays to which colloidal-sulphur has been added. Where there is a risk of damage to foliage or fruit from the use of lime-sulphur during the early summer period it is preferable to switch over to the combination or even use colloidal-sulphur alone. Whichever spray, or sprays, it is decided to use, the closest attention should be given to thoroughness of application, correct measurement of ingredients, and complete coverage. It is only by attention to these matters that an effective control may be secured.

Cultivation.

The continuation of the cultivation of the orchard should not be neglected, as it is only by repeated stirring with either harrow or cultivator that the soil can be reduced to that fine state so necessary to produce a satisfactory soil-mulch. Hoeing round the trees, if it has not already been attended to, should receive attention before the soil becomes too hard. This orchard practice is not only very beneficial to the trees, but is the means of destroying any volunteer growth and trash which provides a good breeding-place for pests and diseases. Light cultivation by means of disks, scarifier, or other means at convenient intervals throughout the season has a great influence on the quality of both foliage and fruit and should therefore receive the attention due to it.

Grafting.

During the past two or three years an increased number of apple-trees have been reworked to other varieties. It is still being carried on extensively, as growers have come to realize that it is not profitable to grow varieties that do not even pay ground-rent. The question of which varieties to work is an important one, consideration having to be given as to whether the new variety is required for the export or for the local market trade. Some consideration should also be given to varieties already grown in the orchard, whether early or late, dessert, or cooking, coloured or green, susceptibility to disease, &c., and whether the resultant crops are likely to find a ready market. The tendency should be to decrease the number of varieties grown rather than increase them. Therefore before starting grafting operations full consideration should be given to these points; it may save disappointment in the future. Grafting is not a difficult task, although several points have to be kept in mind. Even with the greatest care it is not always possible to get 100 per cent. take, especially if the scions have not been kept in a dormant condition or the buds are in an unhealthy state. Some growers have been inclined to leave the grafting until the weather becomes hot and dry, and then wonder why "the take" has not been up to expectations. Accuracy in cutting, both scion and stock, has a great influence on the results obtained, whilst neatness of work should be the aim of the operator. If these important details are attended to, the union between stock and scion will soon take place, and then the buds on the scion will break into growth. The method usually employed is known as "bark" or "rind" grafting, although on occasions, if the stock



GRAFTS.

1, 2, 3. Whip graft for use when stock is thicker than scion.
4, 5, 5*a*, 6. Whip graft for use when stock and scion are equal in thickness.
7, 8, 9. Notch graft: scion for old trees, and section of scion.
10. Improved notch scion with shoulder.
11. Front view of No. 10.
12, 13, 14, 15. Rind graft (Fig. 13 showing scion with square edge).

is not too thick, the "whip" graft may be used; but, whichever method is adopted, it is imperative that the fit be perfect as possible, and that the scions be securely attached to the stock, either by means of a small tack or by tying with raffia. The whole of the cut surface must be thoroughly waxed, either with a home-made grafting-wax or with one of the proprietary compounds which are now available on the market. The thorough covering is most important, and should not be neglected, as exposed surfaces offer ready entrance for disease.

The reworking of fruit-trees by the introduction of grafts along the branches, instead of the older method of cutting the tree down to clear the base of the limbs and then grafting, has gained a certain amount of favour recently. There are many points in its favour, although it is a long and tedious operation, and therefore more costly. When one considers that as many as 150 grafts might be inserted along the branches of one tree, the time taken to graft an acre or two would be great. One of the chief advantages with the "porcupine" system is that a full-bearing tree is obtained sooner. Whether this compensates for the extra time taken is questionable. By this method leaders not required in the future tree are cut out, the balance being bared of growth with the exception of any side laterals suitable for grafting. The branches are cut down to the required height and grafts are inserted at regular intervals, taking advantage of any side laterals in a convenient position. A graft is also inserted in the top of each of the leaders. The whole of the cut surfaces are covered with grafting-wax. During the growing season many laterals will grow from the original tree. These can be utilized by inserting buds in February should any of the scions fail to grow, otherwise they must be suppressed.

Fireblight.

Growers are advised to keep a sharp look out for fireblight infection. The disease may be discerned by the discoloration of the blossoms which continue to hang on the trees and by the sudden wilting of new shoot growth. It is mainly through the blossom that the disease spreads to the growing tips of the laterals, and then down the laterals to the main branches. The spread of the disease may be very rapid, enveloping the whole tree if uncontrolled. All affected parts should be cut out below the visible point of infection and destroyed immediately. The secateurs should be sterilized with formal-alchol (commercial formalin 6 cc., alcohol 95 per cent., methylated spirit 94 cc.) after every operation. Any suspected specimens should be submitted to the Orchard Instructor for the district for examination.

The wounds should be treated with acidulated mercuric chloride solution (mercuric chloride 1 gram, hydrochloric acid concentrated 15 cc., water 500 cc.). The solution should be held in glass or earthenware container. It is highly poisonous and should be labelled conspicuously "POISON." It should not be left lying about.

—George Stratford, Orchard Instructor, Motueka.

Citrus Culture.

Pruning.—Citrus trees can be pruned at any time of the year except during their winter period, but the most suitable time is in the spring, when the danger of further severe frosts is past. There is no fixed style of pruning for citrus trees that can be claimed to be generally suitable for adoption in all orchards nor for any individual orchard, as every orchard and every tree has its particular requirements in the way of pruning. The need for this variation of treatment is much greater in citrus than in any other class of fruit-trees. The pruning, however, should be sufficient to maintain a fairly open-headed tree furnished with a good supply of thrifty fruiting-laterals. A systematic pruning at the time of planting is, however, of the utmost importance. Trees should then be pruned in much

the same manner as deciduous fruit-trees, from three to four branches being selected to form the framework. The branches should be arranged spirally on the trunk and not opposite each other. The lowest branch should be at least 2 ft. from the ground. All branches that are not required should be removed. These framework branches need not be shortened provided they are of equal vigour, have not been injured by frost or other causes, and are not exceptionally long. During the following three years frequent light prunings are necessary, particularly for the purpose of removing superfluous shoots and crossing branches. Any branches which are growing vigorously to the detriment of others should be frequently pinched back to give the tree a balanced head.

In later years much greater variation in the treatment of individual trees is necessary. It is not possible in these notes to describe all of these treatments. Probably the three most important aspects of pruning mature trees are—(1) the maintaining of a fairly open head, (2) the reinvigorating of fruiting-laterals, limbs, and even entire trees that show signs of lacking full vigour, and (3) the removal of all dead wood. The degree of severity with which to prune must vary, according to circumstances, from a removal of spent fruiting-laterals, as is frequently found in the interior of lemon-trees, a shortening-back of branches and strong lateral growths to cause them to send out fruiting wood nearer their base, to a complete skeletonizing of the entire tree in cases of extreme debilitation. It is also important that shoot-growth killed by frost should be removed as soon as the danger of further frosts is past. All cuts more than ½ in. in diameter made in pruning should be covered with a wound-dressing of the bitumen-emulsion type.

Manuring.—If the spring dressings of fertilizers and manures have not yet been applied, this work should be put in hand as early as possible, as it is now becoming late for such applications. Where available, farm-yard manure of any kind should be given preference, and this can be supplemented by a quick-acting nitrogenous fertilizer such as sulphate of ammonia. Annual dressings of blood-and-bone manure at the rate of 8 lb. to 12 lb. per tree is giving good results.

Budding.—If it is intended to rework citrus trees the budding should be proceeded with as early as possible to ensure satisfactory growth during the current season. In selecting budwood it is important that only well-matured wood should be used. Plump shoots of the type that usually produce fruit give the best results. Flat or angular growth is undesirable. Different types of citrus budwood are shown in the accompanying illustration.

Verucosis.—In some instances growers do not appear to realize that the rough condition of the rind of their fruit is due to this disease. The fruit is most susceptible to infection about the time the first blossoms are shedding and while the fruit is quite small. The most dangerous period for infection is when the fruit of the main crop is setting. In orchards where the disease has become established three applications of Bordeaux-mixture spray at a strength of 3-4-50 are recommended as follows: (1) When the earliest fruits of the main crop are setting; (2) Repeat three to four weeks later—this repeat spray is very necessary; (3) a spraying during the autumn blossoming-period is also required to ensure a clean crop. Where black aphis or scale insects are troublesome it is good practice to add summer-oil at a dilution of 1–1000 to the Bordeaux sprays. Where black aphis is the only insect troublesome at the time, nicotine sulphate, 40 per cent., can be used in the place of summer-oil at a dilution of 1–800.

Cultivation.—The surface soil should receive cultivation sufficiently frequently, for the next few months at least, to prevent a crust forming

on the surface of the soil and to retard the growth of weeds. There is a tendency on the part of many growers to cultivate to a depth of 8 in. to 10 in., particularly on the light pumice soils. This practice of deep cultivation is believed to be responsible for the general unhealthy

DIFFERENT TYPES OF ORANGE BUDWOOD.

On left, old and blind type; two in centre, flat and angular type; two on right, desirable type.

appearance of many citrus orchards. A tilth of from 3 in. to 5 in. is all that is required in most types of soil, and deeper cultivation is liable to destroy valuable feeding-roots without offering any advantage.

—*P. Everett, Orchard Instructor, Gisborne.*

POULTRY-KEEPING.

Preserving of Eggs.

ALTHOUGH much has been accomplished during recent years by improved methods of poultry-keeping to bring about a greater production of fresh eggs during the winter months, it may still be said that eggs are a seasonal product.

The average monthly production of a good flock of first-year leghorns should be in the vicinity of the following: April, 22 per cent.; May, 51 per cent.; June, 52 per cent.; July, 58 per cent.; August, 65 per cent.; September, 74 per cent.; October, 75 per cent.; November, 68 per cent.; December, 64 per cent.; January, 56 per cent.; February, 55 per cent.; March, 32 per cent. Owing to this uneven seasonal production, which results in a surplus during the spring months and a shortage during the late autumn and winter months, it is an economic proposition to preserve eggs during the flush season for use during the off periods. September, October, and November are the months of greatest production, and eggs naturally cost less to the consumer then than at any other time of the year, and a good saving may be effected in the home if householders preserve eggs when cheap for use during the scarce and dear season. Apart from the fact that eggs are cheaper, the spring and early summer are the best times to preserve, for, generally speaking, eggs produced at these times are of better quality and possess better keeping-qualities than those produced during the hot weather.

Those intending to preserve should lose no time placing down their requirements. Only fresh, clean, and sound-shelled eggs should be preserved, as one or two dirty, cracked, or musty eggs may spoil the lot. For this reason all eggs should be tested for cracks and internal quality before being placed in preservatives.

To test for cracks take an egg in each hand and gently tap them together; if the shells are sound they will give a true ring, but if one is cracked the sound will be dull and quite different.

Examination for internal quality can be made by the use of a tester and by holding the eggs to a strong light. By this method any defects can be detected at once. A simple tester can be made from heavy brown paper, such as illustrated on page 52 of the Department's Bulletin No. 66, "Utility Poultry Keeping," a copy of which may be obtained from the Publisher, Department of Agriculture, Wellington, at a cost of 1s., postage free.

It is advisable to allow the animal-heat to get out of eggs before they are placed in solution; as an instance, eggs laid to-day would be better if kept in a cool place for about twenty-four hours before being placed in preservatives. Thoroughly clean jars, crocks, or tins should be used to preserve eggs in, and these vessels should be kept in a cool dry room with plenty of ventilation.

There are several useful mixtures and brands of preservatives on the market. Some householders put eggs down in dry salt or even bran. A lime-water solution is sometimes used, made up of 4 measures of fresh, finely slaked lime mixed with 20 parts of water and 1 measure of salt. The whole is well stirred together a day or two before using; the clear liquid is then poured off and the eggs placed in it. A more popular preservative and one used with almost universal success is water-glass (silicate of soda); this material is sold by most chemists and grocers for the purpose. The water-glass should be diluted just enough to allow the egg to sink, say, from ten to fifteen parts of water to one of water-glass according to its strength. The water should be boiled and allowed to cool before mixing in the water-glass. Eggs may be added from time to time until the vessel is full, but at least an inch of the solution should cover the top layer of eggs. When the vessels are full they should be covered over in order to prevent evaporation of the solution.

Eggs should be washed when taken from the preservative and if they are to be boiled it is advisable to prick the thick end, otherwise expansion is likely to cause them to crack.

October Brooding.

October-hatched chickens are, as a rule, much more difficult to rear artificially than those hatched earlier. Especially is this so if the weather is warm and muggy nights are experienced.

Efficient management and close attention to all little details is required to make a success of the later-hatched chickens. It frequently happens that the poultry-farmer has so much to do at this time that he is unable to give that extra time to the last batch of chickens, which often means so much for their welfare.

The chief essentials to successful artificial brooding are proper warmth, a constant supply of fresh air, ample room under the hover, dryness, and cleanliness. Poultrymen of experience seldom use a thermometer when brooding chicks as they depend upon the action of the birds to indicate whether the correct temperature is being applied. There is with some a tendency to use the same amount of power or flame during October as previously used during the colder months, resulting in the chicks being compelled to sleep in an overheated atmosphere, and consequently they do not thrive. Where the beginner is not satisfied with the progress being made by his chickens he would be wise to place a thermometer under the hover about an hour after the brood has camped for the night, and the cause, or one of the causes, of unthriftiness may be detected.

The trouble known to poultrymen as "green-leg" or "green-wing," the chief symptoms being a swelling of the head, neck, and hock joints, often makes its appearance about this time of the year. It is really the result of incorrect night conditions such as overcrowding of the brooder, lack of proper ventilation causing the chicks to breathe the impure air, a condition which also causes the bedding to become damp when a moist atmosphere is created. Treatment for this trouble is of little avail; it is more a matter of prevention.

If a frame is not used to brood the chicks in, as recommended in Bulletin No. 66, "Utility Poultry Keeping," one should be installed. When a frame is in use care must be taken to see that the netting or sacks are tight so that no pockets or hollows are created to encourage the chicks to huddle together; plenty of dry, clean bedding-material should be provided, as a little extra depth of bedding will often help to prevent huddling. Visit the chicks just as they are camping for the night and see that they do not cluster together. If they show a tendency that way they should be gently spread out, and it is advisable to stay and watch them until they have settled down for the night. When the canopy type of brooder is used it is a good idea to very gently lift the hover a little, after the birds have settled down. Above all, avoid overcrowding; in fact, place fewer chicks together as the weather becomes warmer. The cockerels should be picked out as soon as possible and allow the extra room for the pullets.

Well-brooded Leghorn chicks should be ready for perching between six and seven weeks old, but they should be hardened off gradually. It is well to make sure that plenty of trough-feeding space is available so that all birds can feed at once.

Green Foods.

It is true that chickens and fowls may be kept without green food, but there is a big difference between those that are given a regular supply and those that are not. Green food seems to put new life into the stock, but it should be fed regularly, at least twice a day to chickens and at regular times, otherwise they are likely to gorge. Provision should now be made for a regular supply of green food for the coming months, as no poultry-farmer can afford to be without a good, green food-patch for his birds.

Chick-sexing Examination.

A chick-sexing examination was held at the Wallaceville Poultry Station on Thursday, 26th August. Six candidates presented themselves for examination, one for a first-class certificate, two for renewals of their second-class certificates, and three for second-class certificates.

Mr. W. H. Barnes, who sexed 50 chickens in ten minutes, with an accuracy of 96 per cent., qualified to have his second-class certificate, which he gained on the 4th November, 1935, renewed.

Mr. J. C. Jamieson, who sat for a first-class certificate, but failed to qualify, sexed 200 chickens in twenty-five minutes with an accuracy of 92½ per cent. His second-class certificate, which he gained on 27th August, 1936, will be suitably endorsed.

The idea of the endorsement of an existing certificate is to show that the person concerned is in practice and able to operate with a good degree of proficiency.

—C. J. C. Cussen, Chief Poultry Instructor, Wellington.

THE APIARY.

Food-supply.

In districts devoid of native bush, where the bees are practically dependent on the flora found in the open paddock, it will be necessary to keep an eye on the food-supply during November. Willows, dandelion, and fruit-trees will have ceased to bloom, and while there will be a little clover in flower this is not likely to secrete nectar. Clover is very susceptible to climatic conditions, and the right conditions for its secretion of nectar do not usually prevail until the end of November or early in December. Hawk-weed and cape-weed will then be in full bloom, so in districts favoured with abundance of this flora there should be a good flow about the time stated. In the meantime care should be taken that the bees are not allowed to starve—it is a critical stage in the life of the colony.

Swarming.

Given reasonably fine weather some colonies will have become very strong and, unless steps have been taken to prevent it, overcrowded and inclined to swarm. It is best to keep down swarming as much as possible, and to make any increase desired in anticipation of the natural tendency. If no increase is desired, the simplest way to keep down swarming is to provide the bees with plenty of room and offer them inducement to avail themselves of it. This is best accomplished by giving them a super containing, for preference, nine combs—assuming that it is a ten-frame hive we are dealing with—the centre comb being a frame of brood lifted from the brood chamber and replaced by an empty comb. It is not sufficient to merely place the super of empty combs over the brood-chamber; the frame of brood must be lifted and placed in its centre. Where half-depth supers are used this is not practicable; in such cases it is advisable to make a practice of carrying over some partially filled combs from year to year. Even when it is intended to produce section honey it is best to draw the bees first into a super of ordinary combs. When the bees have become accustomed to working in the super it can be removed and a rack of sections substituted.

Despite every precaution, however, the bees will sometimes swarm. It will not be a very serious set-back to the apiary if a few colonies do each cast one swarm, but after-swarms must be prevented as far as possible. The first swarm will be headed by the old queen, and will, given fine weather, come off as soon as the first queen-cell is sealed. Swarms, especially those headed by a laying queen, almost invariably settle within

a few minutes close to the apiary. It is not safe to reckon on the bees remaining long at their first resting-place, however, especially if this is a sunny situation; they may rise again within ten minutes and fly for miles before again settling.

To take the swarm procure a benzene-case or similar box and hold under. If the bees have settled on the branch of a tree shake them with a vigorous jerk of the branch into the box; when this is not practicable brush them in. Then as quickly as possible slip a bag over the box and turn it upside down, placing a stick or stone under one corner to provide an opening for the bees. Leave the bees in this box until at least 4 o'clock in the afternoon, then take them to the site of the prepared hive and, after placing a sack on the ground, shake out the bees immediately in front of the hive. In dealing with a swarm at an out-apiary where it is desirable to hive it at once it is a good practice to place in the centre of the hive a frame of open brood taken from an established colony. This will prevent the bees absconding. The greatest care, however, must be exercised to ensure that disease is not thus transmitted. In hiving a swarm under such conditions place an empty super on top of the prepared hive, take the swarm in a bucket, and then shake the bees into the super. The frame of brood in the hive below generally attracts the bulk of the bees downwards; the balance can then be brushed from the sides of the super, the super taken off, and the swarm taken in a few minutes to its permanent location in the apiary.

To check any further swarming look over every frame carefully and cut out all but one queen-cell. It is necessary to handle the frames as gently as possible; do not shake the bees off the combs lest the one remaining queen-cell is destroyed. There is a possibility that the bees may swarm out with the young queen when she takes her maiden flight. If this does happen, put them back again without fail.

General.

The hives should be rested on bricks or stands of some description, raising them about 6 in. off the ground. Place the bottom-board with a slight slope toward the front. Keep down the grass and weeds about the hive; a tangled entrance which hinders the exit and entry of the bees seriously affects the honey crop. If gable roofs are used, do not fail to use mats to prevent the bees building in the roof. Mats are not necessary with flat roofs.

—E. A. Earp, Senior Apiarist.

HORTICULTURE.

Vegetable Crops.

To produce good crops from seed, weeding requires close attention, especially while the crop plants are small. When the plants cover the ground there is less danger of their suffering a set-back owing to the competition of weeds for the available light, air, moisture, &c. Many crops are lost by being overgrown by weeds or only small crops are harvested at an uneconomical cost owing to the amount of labour spent on weeding. Serious weeds, such as couch-grass or twitch, are usually worked out of the ground before sowing, although not infrequently one finds a grower sanguine enough to sow or plant a herbaceous crop in ground infested in that way. Most of the weeds infesting a crop are from seeds in the ground which have been grown there, or have blown in, or have been brought in by birds. Stable manure, straw, or organic matter of many kinds that are ploughed under to enrich the soil may include weed-seeds unless the material is thoroughly fermented, when in most

instances they are sprouted and destroyed during the process. After deep cultivation land that was considered to be clean sometimes produces a heavy growth of weeds from seeds brought up near the surface from below, where they have lain dormant for years. Such is the hardihood of some weed-seeds.

The labour and cost of weeding is greatly reduced if during the preparation of the land for sowing it is allowed to lie and settle down for a fortnight or so after deep and thorough cultivation has been given. This rest allows the weed-seeds near the surface to sprout, when they may be readily destroyed on a fine day by means of a shallow stroke with hoes. If the crop is then sown without further deep cultivation, which may bring up more weed-seeds, the labour of dealing with this problem is greatly reduced.

Thinning the crop is also a formidable undertaking with many growers. Where plants are crowded in the rows it is impossible to obtain a good crop unless they are thinned out, which, under the best conditions, is a tedious undertaking. This labour is almost entirely avoided by carefully considering the germination percentage of the seeds and the desired distance between plants. They may then be sown sufficiently thin in the row to produce a crop which will require little or no thinning out afterwards.

Weeding and thinning seedling crops should now be given prompt attention as required. Weeds should be destroyed while small before they produce rough leaves, during fine weather; and thinning should be done shortly after rain, when the young plants draw easily.

The shortage of organic manures makes it necessary, in most places, to carefully compost all available material. This means all animal and vegetable material which can be reduced to a thoroughly decayed state in about twelve months. This eliminates chiefly large bones and hardwood branches of any size, which are best burnt. The remainder should be built into a compact stack with perpendicular sides, in a humid shaded place, which are the conditions most conducive to decay. The method is to remove a foot of soil from an area 4 ft. to 6 ft. wide, and as long as necessary, piling the soil in equal quantities on either side. In this trench hedge-clippings, lawn-grass, house waste, fowl-manure, weeds, &c., should be built into a compact stack as it becomes available. About the time of the New Year the stack should be sealed by covering it with the foot of soil which was removed from the foundation.

Where soil is required for seed-boxes, potting, and top-dressing a stack of sufficient size should now be built of the top-spit of old pasture with the grass downwards. If at the end of twelve months it is cut down, broken up, and restacked it should be ready, after two or three years, to form the main ingredient in a first-class compost for the purposes mentioned above.

Where grassland is to be broken in for cropping a commencement may be made now by ploughing it shallow, just sufficiently deep to get beneath the roots of the present vegetation and turn it upside down. When the turf has been killed, so far as possible, it should be cultivated and harrowed to enable all twitch and other perennial weeds to be gathered and burnt before deep ploughing, in readiness for planting a crop during the autumn. The summer season usually affords good opportunities for cleaning foul land in this way. If the operation is not completed, then it may be necessary to sow the land down thickly with a cover crop at the time of the first autumn rains, with a view to smothering any weeds which remain.

During the month of November the sowing and planting of the half-hardy crops mentioned last month may now be done in the cooler districts, also garden swede-turnips should be sown.

Small and Sundry Fruits.

For about three months during the Christmas period the main berry crops are ripe and mark the season of summer-time. Tree fruits are

practically off the market, and a good demand can always be relied on for these attractive berries. Most of them are very perishable unless, for long distance shipping, they are picked in firm condition. Even when the greatest care is taken such fruit as raspberries depreciate badly if subjected to much delay and handling. For this reason the distribution of these crops requires careful consideration, and definite plans made before harvesting commences. Picked when dry, of even maturity, and packed in clean bright packages, nothing in its class is more attractive.

During the month of November tomatoes in the unheated glasshouse commence to ripen. Watering, feeding, and ventilation then require close attention to maintain health and vigour while the crop is developing. Just what this means will depend on the soil and subsoil, also the climate, especially as regards temperature and sunshine. With four or five bunches of fruit set, some nitrogen may now be included in the manurial treatments without fear of the plants bolting to rank growth, but, even so, moderate quantities at intervals of a fortnight are better than larger doses at longer periods. Where there is any doubt as to the most suitable prescription, the following mixture may be tried, and afterwards modified as may be found advisable from the reactions experienced in the plants: Dissolve ½ oz. nitrate of soda, 1 oz. superphosphate, and ½ oz. sulphate of potash to each gallon of water, and apply at the rate of about one quart of the solution to each plant the day after watering. Before the fruit commences to colour it is usually advisable to lay a mulch of strawy stable manure or clean straw to conserve moisture and prevent splashing when watering. At the same time the base leaves, up to about the first bunch of fruit, are cut away, carried out, and destroyed. Among other things, this assists the colouring of the fruit and improves the circulation of the air in the house.

The tomato-weevil has been reported recently as doing serious damage to this crop under glass. The mature larvæ of this insect are legless, light green in colour, and about ½ in. in length. They are active during autumn, winter, and spring, when they enter the ground and form an earthen cell and the pupa is formed. The adult is a typical weevil, slow-moving and nocturnal in its habits; it feeds on vegetables of many kinds and some weeds, destroying chiefly the tender crown leaves; but the attack of larvæ on tomato crops in spring is the damage which has chiefly come under notice here. The control of *Listroderes costirostris* (*Desiantha nociva*) is by means of thorough cultivation of the soil, especially during late winter and spring, when the insects are passing through the pupal stage and are easily destroyed: the Paris green or arsenic poison bait broadcasted before planting as for cut worms; and spraying the plants attacked with a solution of arsenate of lead.

During the month of November the planting-out of half-hardy crops, mentioned under this heading in notes last month, should be completed. If this is done with care there will be little check to growth and the crops will be earlier and bigger. To water the plants the day before transplanting is usually advisable. Disturb the roots as little as possible, and do not expose them unnecessarily to the air; plant firmly, deep rather than otherwise, and avoid injuring the base of the stem when firming the plant are some of the necessary precautions.

The Homestead Garden.

Everybody appreciates a garden even if they do not like gardening. Good tree-shelter breaking the force of prevailing winds and rain is of decided utility for those who have to spend much of their time outside and greatly facilitates the maintenance of suitable temperatures in the home, while deciduous trees, well placed, afford shade for property and stock during warm summer days, which is quite as valuable. These features,

which necessarily include grassed open spaces of proportionate size, practically make up the garden, if areas for the production of fruit and vegetables are included. The selection of trees and shrubs for the above-mentioned purposes in any particular locality—their number, arrangement, and position—are matters requiring a great deal of consideration if it is to be done effectively without loss of time. In most instances it is the deciding factor, and where careful consideration is given generously the result is invariably good. In addition to one's own experience and preferences, it is advisable to carefully study the behaviour of mature trees and shrubs in the locality growing on the same class of soil, and under most circumstances it will be best to confine oneself to using only those which have proved successful. Decisions arrived at should be recorded in the form of a plan, to scale, on graph-paper with squares about ten to the inch. Each operation in the undertaking can then be carried out in season according to plan as opportunity offers.

Where gardens and gardening afford pleasure those living in homes in the country have special opportunities for the enjoyment of the art. Lawns may then be used for out-door sports, and an enclosed garden affords privacy and shelter for leisure moments, where, if garden seats are provided in shaded and sunny arbours, it will be popular with old and young at most seasons of the year. The summer period now commencing is most suitable for studying the problems connected with the construction of new gardens and alterations and additions to old ones, so that plans may be completed and ready for execution during the autumn months, which are perhaps quite the most suitable for that purpose.

Other work for the month of November includes the planting-out of half-hardy flowering annuals, dahlias, and chrysanthemums, also training and tying climbing plants, and plants in the herbaceous border. Common troubles which commence to make their appearance at this season are rose aphis and mildew. To keep the plants quite free from these troubles it is often necessary to spray them at regular intervals, and an early commencement is a great advantage. For the control of mildew some form of sulphur is the best remedy. The most generally useful probably is lime-sulphur, one part to fifteen of water applied as a fine spray in autumn, as soon as the leaves fall, and again just before growth commences in the spring. At the present time colloidal sulphur 2½ oz. to 4 gallons of water is best, or potassium sulphide, 1 oz. to the gallon, may be used. For aphis-control any contact insecticide will destroy them—nicotine sulphate is commonly used—but owing to their wonderful fecundity reinfection soon takes place in fine weather, and spraying must be repeated; where the attack is persistent a weekly application is sometimes necessary.

—Wm. C. Hyde, Horticulturist, Wellington.

A farmer of Tirau who owns a farm of 340 acres, carrying-capacity 1,300 breeding-ewes and from 180 to 200 head of cattle, has had good results with basic slag in top-dressing this past season. When growing root crops and sowing down permanent pasture his manurial treatment is equal parts of super and bones at the rate of 3 cwt. per acre. When old pasture is ploughed for root crops he applies 12 cwt. of carbonate of lime on the furrow. His usual top-dressing mixture is one sack of superphosphate (1¾ cwt.) and 1 sack of lime (1 cwt.) per acre. Last autumn he top-dressed part of his farm with basic slag at the rate of 3¼ cwt. per acre and the usual super-lime top-dressing on the remainder. The lambs from the ewes on the slagged country were all sold and forwarded to the freezing-works on the 20th November in one line; late lambs doing very well. Only one-third of the lambs from the super-lime top-dressed country were ready and sold at this same time.

ANSWERS TO INQUIRIES.

IN order to ensure reply to questions, correspondents must give their name and address, not necessarily for publication, but as a guarantee of good faith. Letters should be addressed to the Editor.

SPECIFICATIONS AND COST OF A SHEEP-DIP.

P. G. A., Tirau :—

Could you supply me with the specifications and cost of a sheep-dip to deal with three or four hundred ewes ?

The Live-stock Division :—

You have not stated which particular type of dip you favour, but as the " pot " bath is by far the most common in small sizes we will assume you favour this type. The sizes given are about the minimum economic size to build, as anything smaller will be too slow to work. A larger bath (which you would be well advised to build if you are anticipating an increase in the size of your flock) will be more expensive for first cost and in the fluid left unused at the bottom after dipping, but, on the other hand, will be correspondingly quicker and easier to work. The usual shape for this type of dip is conical like a gigantic flower-pot, but as the boxing required to mould the concrete is rather difficult to shape in the circular form, the average farmer will find it much easier and just as effective to make the bath square with the extreme corners removed. This will do away entirely with any curves, and the boxing is then a straightforward job. You will find suitable dimensions to be : (*a*) In the case of a round dip, 6 ft. inside diameter at the top, and 3 ft. inside diameter at the bottom ; vertical depth, 5 ft. (*b*) For a square dip, 6 ft. square at the top and 3 ft. square at the bottom ; vertical depth, 5 ft. The corners are cut off 1 ft. from each extreme corner—*i.e.*, a plank 17 in. wide is used to block off the corner. In each case the exit commences 1 ft. (vertical measurement) from the bottom of the dip and rises on an easy slope for 11 ft. (The horizontal measurement at ground level of the exit from the top inside rim of the bath is 9 ft.) The exit has a surface width—*i.e.*, at any point along the top—of 20 in. ; the sides sloping down to a width of 12 in. (inside measurement) at the bottom. The same exit is used with either circular or square bath, and is provided with a vertical sliding wooden gate, preferably counterbalanced, where it leaves the dip. The capacity of these two dips when filled to within 6 in. of the top (this amount of freeboard is necessary) is approximately 620 gallons for the square dip and 550 gallons for the round one. In each case the bath is built of reinforced concrete. Two draining-pens should be provided, each measuring about 10 ft. by 30 ft., as this will mean that while one is being filled up the sheep in the other will have had time to drip sufficiently. These pens should be floored with 3 in. reinforced concrete on a gentle slope, and all run-off should return to the bath via a sump and strainer to catch the dirt, and enter the bath well away from the sheep exit. With prices fluctuating as they are to-day, it is impossible to give even a reasonably exact estimate of the cost, but most firms interested in this work would be willing to give an estimate.

VALUE OF CLUSTER PINE (PINUS PINASTER).

L. J., Taotaoroa, Cambridge :—

I have on my place, coming up very thickly, groves of the Pinaster pine, commonly known in the locality as wild pine. They are spreading very fast over country which can easily be brought into grass. I had decided to cut them, all except those on the steep faces and clumps and wind-breaks that would form good shelter. As they range in size from 2 in. to 12 in. in diameter and are in places as thick as 12 ft. apart, the task is likened unto bush-felling. Before I go much further I would like to have an expert opinion on the potential value of the Pinaster pine. Hitherto I have understood them useless and that grass would pay much better, but as the job is likely to be big in cutting them, I would like to make sure they will be no use in the future. The trees are extremely fast-growing. Five years ago they were just above the fern.

Horticulture Division :—

The planting of cluster pine (*Pinus pinaster*) is usually confined to seaside planting, where it makes useful shelter. As a timber tree it is of less value than *P. radiata* and others, but as it is established on your place and doing well the proposal to use it as shelter and, say, firewood, as you suggest, seems appropriate. The question of its timber value here, and whether it should be allowed to grow on land easily brought into grass, is best referred to the Forestry Department. The inquiry should be addressed to " The Director of Forestry, State Forest Service, 47 Fitzherbert Terrace, Wellington, N. 1."

SOWING OF CHOU MOELLIER FOR MAY FEEDING.

E. R., Wairoa (H.B.) :—

I am thinking of sowing a paddock of 6 acres, which carried a crop of turnips last winter and was fed off by sheep, in chou moellier this spring for feeding off by sheep in May, and should be very glad if you could give me the following information : (1) The best time to sow ; (2) quantity of seed to sow through a drill per acre ; (3) distance between rows ; (4) the most suitable fertilizer and quantity per acre. I presume that thinning is not necessary. Could you also tell me if there is more than one variety of chou moellier, and, if so, which is most suitable for sheep.

Fields Division :—

Taking your questions numerically, I answer them as follows : (1) If you wish to feed off in May the seed should be sown in early November ; if you were to sow any earlier it would probably run to seed before you were ready for it ; (2) and (3) 2 lb. of seed to the acre is the usual practice, sown in drills 14 in. apart (every other coulter) ; (4) sown as above, 3 cwt. of super or neutralized ammoniated super to the acre. Chou moellier is a very gross feeder and thrives best on land where well-rotted farmyard manure has been ploughed in and plenty of nitrogen is available. Hence the value of ammoniated super. Very good results have been obtained by first of all giving a top-dressing of 3 cwt. of ammoniated super, followed by drilling in the seed with a further 3 cwt. of super. On heavy clay land it is advisable to top-dress with half a ton carbonate of lime before sowing. It is important to obtain a quick establishment before the dry weather sets in, because, even should the plants be denuded of leaves by parasitic attack, the stems will throw out fresh growth in the autumn. It is most important to plough early and cultivate the land deeply and thoroughly.

WEATHER RECORDS : SEPTEMBER, 1937.

Dominion Meteorological Office.

NOTES FOR SEPTEMBER.

SEPTEMBER was a rather mild month with little storm activity and generally an absence of extreme temperatures. Though the rainfall was considerably below normal over a large part of the country, skies were dull in these areas and there were few drying winds. Over most of the country, and especially the North Island and Marlborough, the rain was sufficient to keep the soil moist. In most districts there has been a good growth of crops, pastures, and other vegetation, but continued dull and wet weather has had a retarding effect in parts of the North Island and in Marlborough. Dry conditions prevailed, however, in most of Otago and South Canterbury, and good soaking rains will be required soon over much of the Dominion, especially if many dry north-westerly winds are experienced. Stock are

in good condition, and the weather has, in most places, been very favourable for lambing. There were some losses owing to excessive rain in Marlborough at the beginning of the month and in Canterbury owing to cold towards the latter end. A rather severe frost occurred in Hawke's Bay and the Manawatu on the 29th, and considerable damage was done to stone fruit and tender crops.

Rainfall.—Conditions as regards rainfall were rather varied over the North Island. Rain was frequent, but many of the falls were light. In the Poverty Bay and Bay of Plenty areas totals were considerably below average, but in most of the Hawke's Bay and Wellington Provinces above it. In the South Island most of Marlborough and North Canterbury had more than the average, but the remainder generally less. Very little rain was recorded in Central Otago.

Temperatures.—Temperatures differed very little from the average for September and the departures from normal showed little regularity. Though the frost of the 29th was severe in the southern portion of the North Island there was no occasion on which severe cold was general. The nights, for the most part, were mild. Where the temperature was below average it was generally due to the prevalence of cloudy skies and low day temperatures. The temperature of the soil is higher than usual for the time of year.

Sunshine.—In the Auckland and Taranaki Provinces the amount of bright sunshine was, at many places, slightly above average. Except at Invercargill, where there was only a slight deficit, the month elsewhere was one of the least sunny Septembers hitherto experienced. Tauranga had 190·3 and Hamilton East 185·1 hours.

Storm Systems.—During the first eight days conditions were unsettled. Several rather indefinite depressions affected the Dominion, culminating in a shallow cyclone which moved from the west across the North Island between the 5th and the 8th. Frequent and widespread rains occurred over the North Island and eastern districts of the South. The western and southern portions of the South Island, however, experienced very little. Temperatures were mild. A number of thunder and hail storms occurred in the North Island.

After a brief spell of anticyclonic conditions and fine weather a series of westerly depressions passed between the 10th and 15th. There were some opportune heavy rains in Westland, where a shortage of water for mining and other operations had been experienced. On the 12th westerly gales blew at numbers of places, and on the 14th some snow fell on the ranges of the South Island.

Fine weather prevailed from the 16th to the 19th. On the 20th another series of depressions commenced, including a shallow cyclone which crossed the Cook Strait area on the 22nd and was followed by strong southerlies on the 24th. Heavy rain occurred in the central provinces. There was cold weather from the 23rd to the 25th, especially over the South Island, where snow fell in places.

On the 27th a rather unusual type of westerly depression crossed the southern portion of the South Island and as it passed a southerly change moved rapidly over the Dominion, gales blowing in the South Island. Snow fell on most of the ranges and there was thunder and hail in places. A similar depression was passing at the end of the month.

RAINFALLS FOR SEPTEMBER, 1937.

Station.	Total Fall.	Wet Days.	Maximum Fall.	Average September Fall.	Total Fall to date.	Average Fall to date.
	North Island.					
	Inches.		Inches.	Inches.	Inches.	Inches.
Kaitaia	5·59	20	0·91	4·90	49·93	43·66
Russell	2·70	16	0·60	4·98	84·95	47·84
Whangarei	..	..	..	4·84	..	49·95
Auckland	4·29	22	0·83	4·05	36·04	38·52
Hamilton	3·49	17	1·07	4·32	31·85	37·43
Rotorua	3·48	19	1·08	4·97	36·50	31·83
Kawhia	..	..	..	4·57	..	40·75
New Plymouth ..	4·79	20	0·73	4·92	44·92	45·33
Riversdale, Inglewood ..	7·24	21	0·94	9·56	70·31	77·16
Whangamomona ..	..	..	..	7·11	..	56·10
Hawera	3·54	20	0·66	3·42	31·03	33·53
Tairua	3·33	13	1·02	4·92	43·87	50·63
Tauranga	3·85	18	0·78	4·29	42·29	40·41
Maraehako Station, Opotiki	4·95	16	1·33	4·21	48·46	41·94
Gisborne	..	..	..	2·99	..	37·28
Taupo	3·64	16	1·16	3·82	25·23	33·12
Napier	2·65	16	0·86	1·93	19·47	24·23
Hastings	2·29	12	0·96	2·63	15·98	26·05
Taihape	3·29	21	0·70	3·04	23·88	26·56
Masterton	3·39	19	0·73	3·00	26·20	29·54
Patea	4·43	22	0·73	3·59	32·44	33·03
Wanganui	3·01	15	0·56	2·87	24·14	26·72
Foxton	2·58	17	0·61	2·40	17·90	23·73
Wellington	3·51	20	1·19	3·20	27·13	32·87
	South Island.					
Westport	..	..	..	8·30	..	70·80
Greymouth	6·32	17	1·15	8·09	73·04	73·06
Hokitika	6·16	14	1·66	9·02	78·35	82·31
Ross	10·32	11	2·23	12·43	95·97	94·81
Arthur's Pass ..	..	..	..	15·29	..	111·36
Okuru, Westland ..	12·96	8	2·65	11·89	112·08	105·69
Collingwood	6·80	18	1·46	9·31	62·98	71·76
Nelson	1·12	15	0·29	3·58	25·02	28·44
Spring Creek, Blenheim	2·54	15	0·95	2·59	20·07	23·23
Seddon	3·24	10	0·90	2·14	19·84	18·76
Hanmer Springs ..	5·40	18	1·21	4·43	26·72	33·91
Highfield, Waiau ..	3·18	18	0·85	2·99	17·75	25·52
Gore Bay	..	..	..	2·94	..	24·25
Christchurch	1·83	13	0·63	1·93	18·30	18·92
Timaru	1·45	11	0·37	1·90	16·06	16·33
Lambrook Station, Fairlie	1·50	10	0·41	2·18	14·31	18·31
Benmore Station, Clearburn	0·90	10	0·29	1·93	19·47	17·95
Oamaru	1·63	14	0·47	1·64	12·88	16·08
Queenstown	..	..	..	2·54	..	21·97
Clyde	0·46	6	0·22	1·05	11·59	10·50
Dunedin	2·19	15	0·58	2·75	32·25	26·88
Wendon	1·42	12	0·40	2·42	32·53	21·69
Balclutha	1·28	12	0·30	1·89	25·79	18·16
Invercargill	2·49	18	0·50	3·24	32·79	33·02
Puysegur Point ..	5·06	19	1·05	6·36	66·45	61·71
Half-moon Bay ..	..	..	..	5·02	..	42·94

Ruakura Farm Training College,

HAMILTON.

THE Ruakura Farm of Instruction is situated in Waikato County, and adjoins the Borough of Hamilton. The farm was established as an experimental station in 1901. The training of farm students was commenced in 1912, from which time twelve students were continuously in residence. In 1920 buildings were erected to accommodate sixty returned soldiers. On the completion of the repatriation work the teaching of farm students was reorganized, and a system of resident instruction was established in August, 1923, the educational institution being termed the Ruakura Farm Training College.

COURSE OF INSTRUCTION.

The course of instruction is designed entirely for the requirements of the farmer—not of the agricultural teacher or research worker. The full curriculum occupies twelve months. The year is divided into two terms of twenty-four weeks. New students may enter the college either in January or June. The first term begins on or about 7th January, and the second term on or about 20th June.

A prospectus giving all details may be obtained from the Director of the Fields Division, Department of Agriculture, Wellington, or the Manager, Ruakura Farm of Instruction, Hamilton.

FEES.

The fee for each term for tuition and board (including soft washing) is £18. All fees are payable in advance. Students leaving before the end of their course are required to give three months' notice.

Stationery is supplied at wholesale prices.

ADMISSION OF STUDENTS.

The course of instruction is open to lads of not less than sixteen years of age and of reasonable educational attainments.

Applications for the second term (1937), commencing 5th July, should be submitted as early as possible.